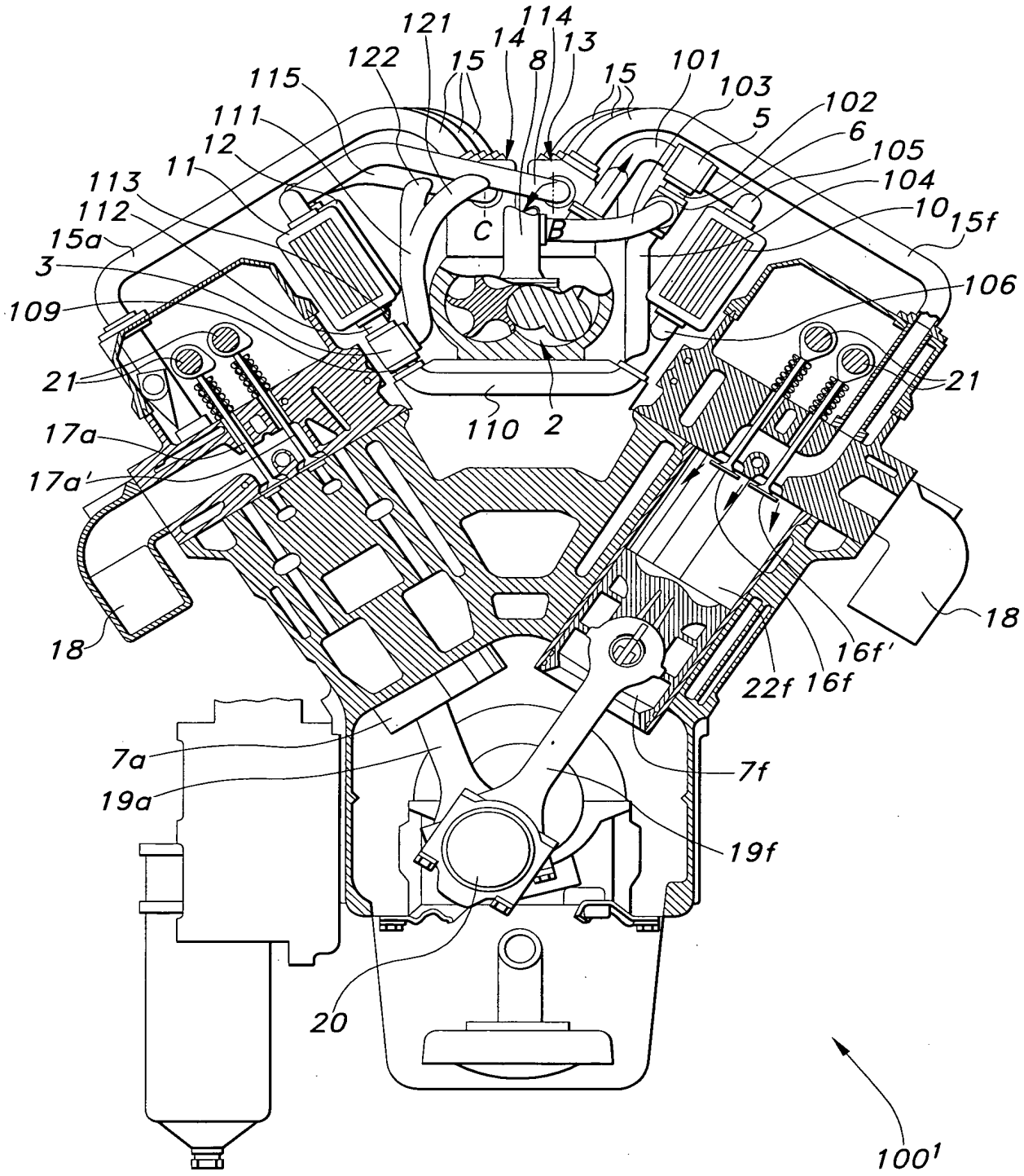

121
114
14
13
122
15
8
15
101
115
103
102
111
5
6
12
105
11
104
113
10
112
15f
C
B
15a
3
106
109
21
21
110
2
17a
17a'
18
18
16f'
22f
16f
7a
7f
19a
19f
20
100'

FIG 1

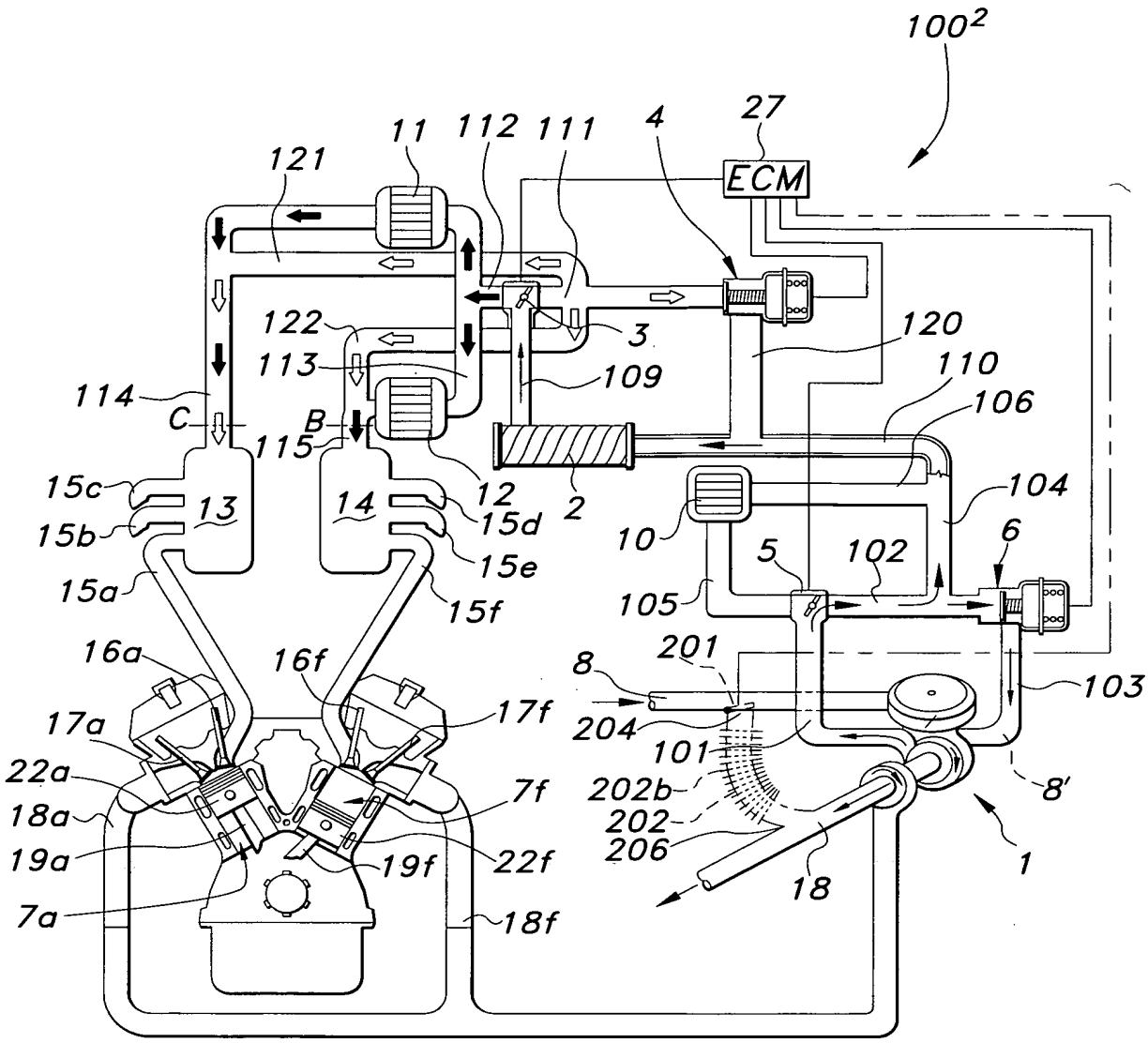

100²
ECM
27
4
11
112
111
121
122
113
114
C
B
115
3
109
120
110
106
104
102
6
5
10
105
2
12
15c
15b
15a
13
14
15d
15e
15f
16a
16f
17a
17f
22a
18a
19a
7a
19f
22f
7f
18f
201
8
204
101
202b
202
206
103
8'
1
18

FIG 2

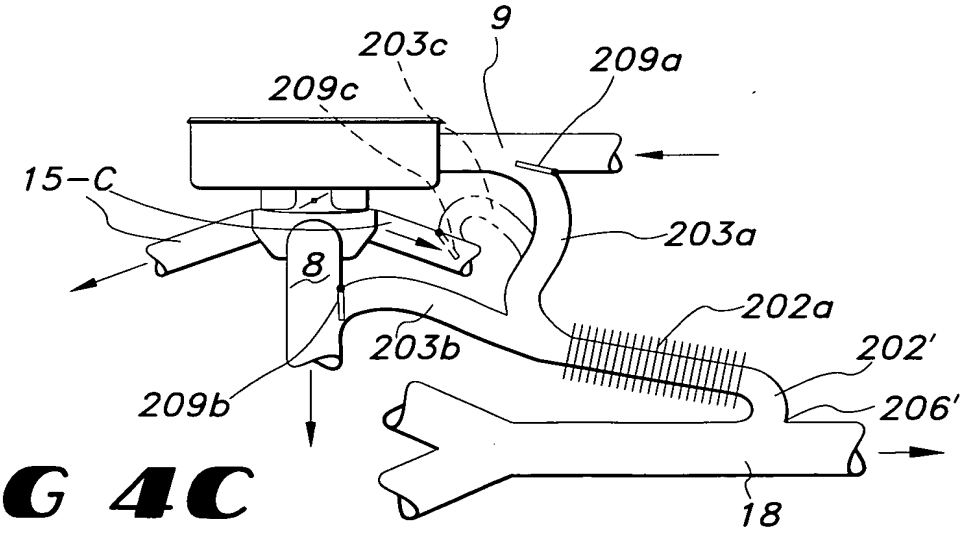

9
203c
209a
209c
15-C
8
203a
202a
203b
202'
209b
206'
18

FIG 4C

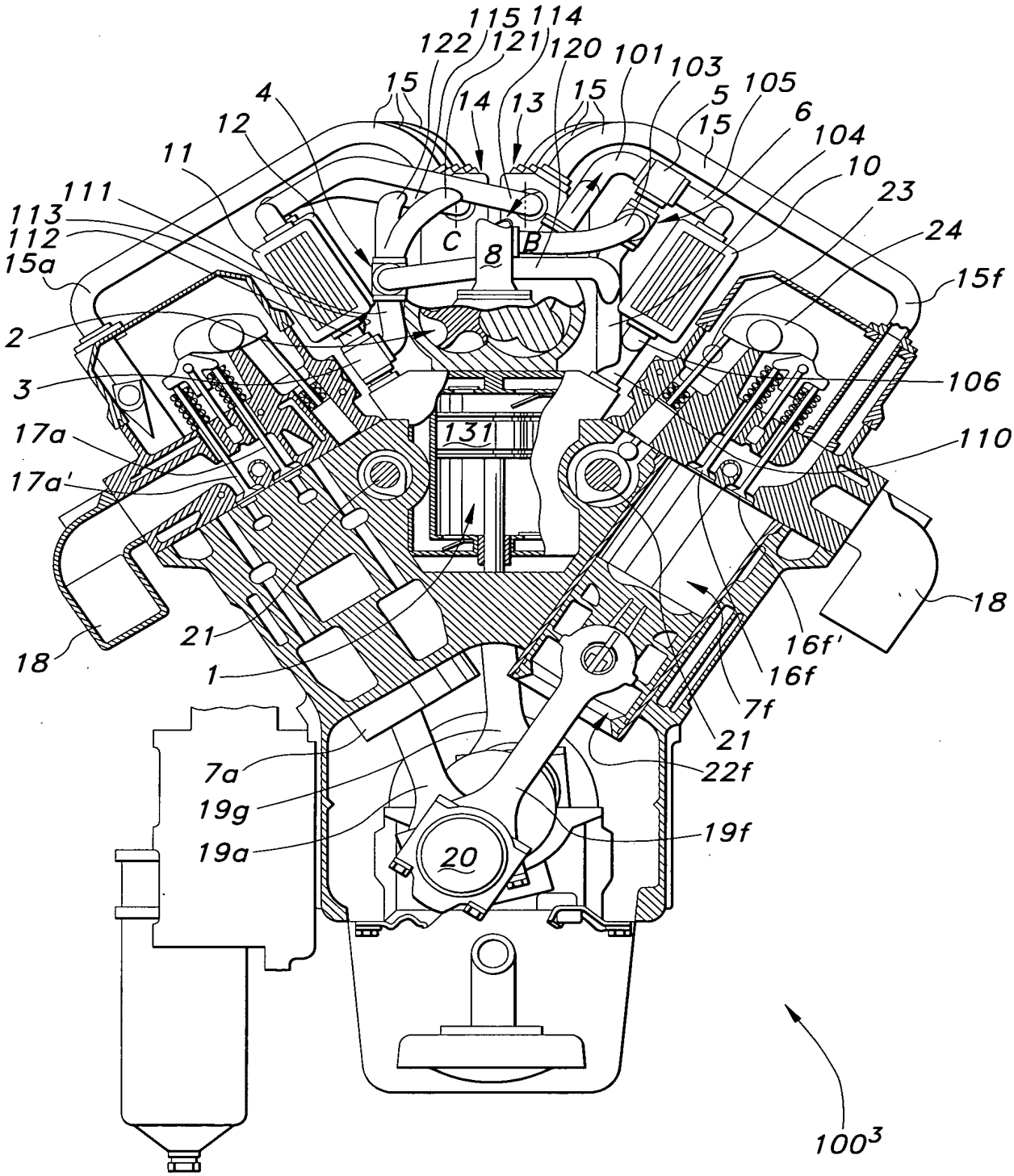

115
114
122
121
120
101
103
105
15
14
13
15
5
15
6
104
4
12
11
10
23
111
113
112
15a
C
8
B
24
15f
2
106
3
131
110
17a
17a'
18
21
1
16f'
16f
7f
21
22f
7a
19g
19a
20
19f
18
100³

FIG 3

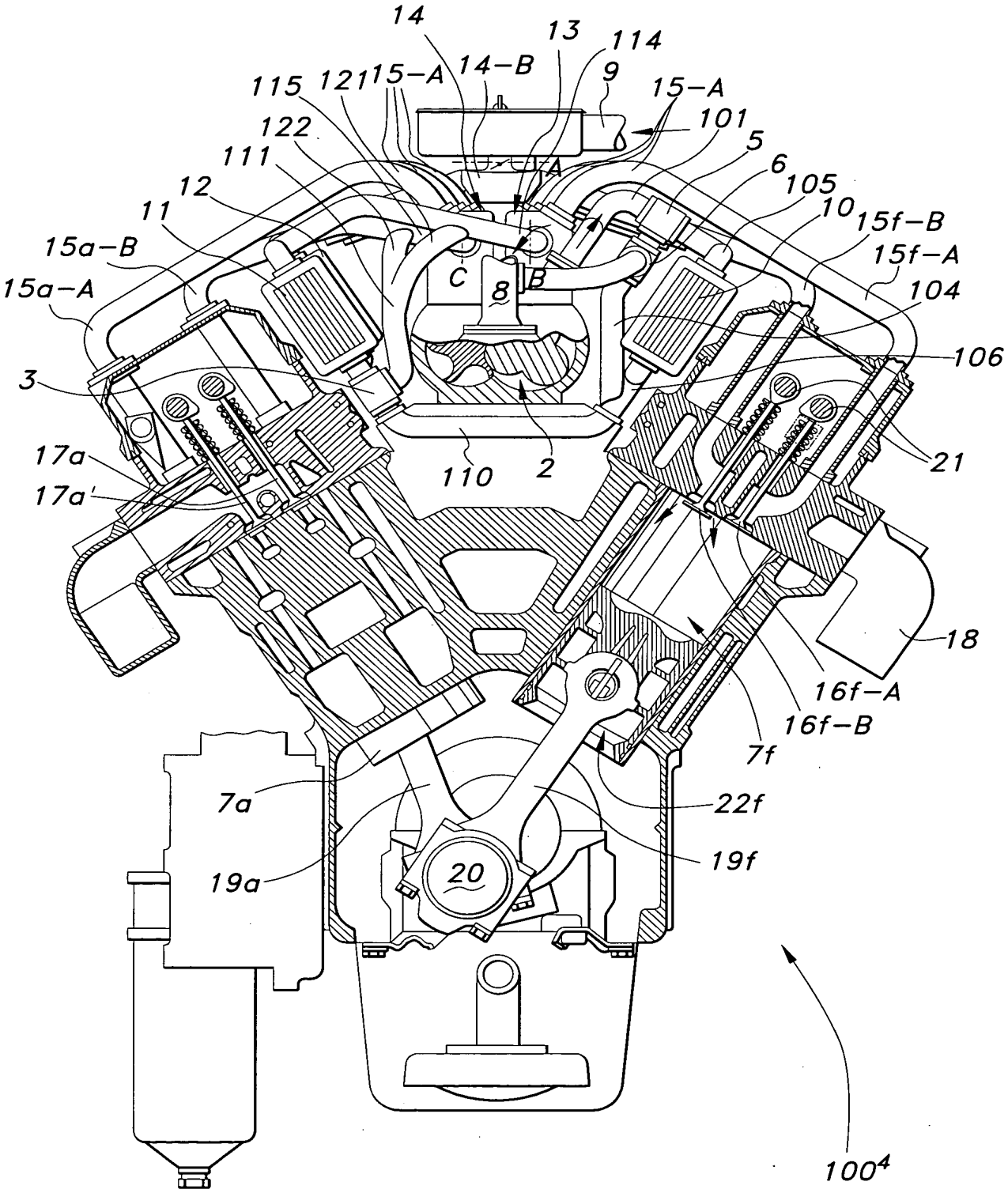

14
13
114
115
12
15-A
14-B
9
15-A
122
101
111
5
6
105
12
11
10
15f-B
15a-B
15f-A
15a-A
C
8
B
104
106
3
17a
17a'
110
2
21
18
16f-A
16f-B
7f
7a
22f
19a
20
19f
100

FIG 4

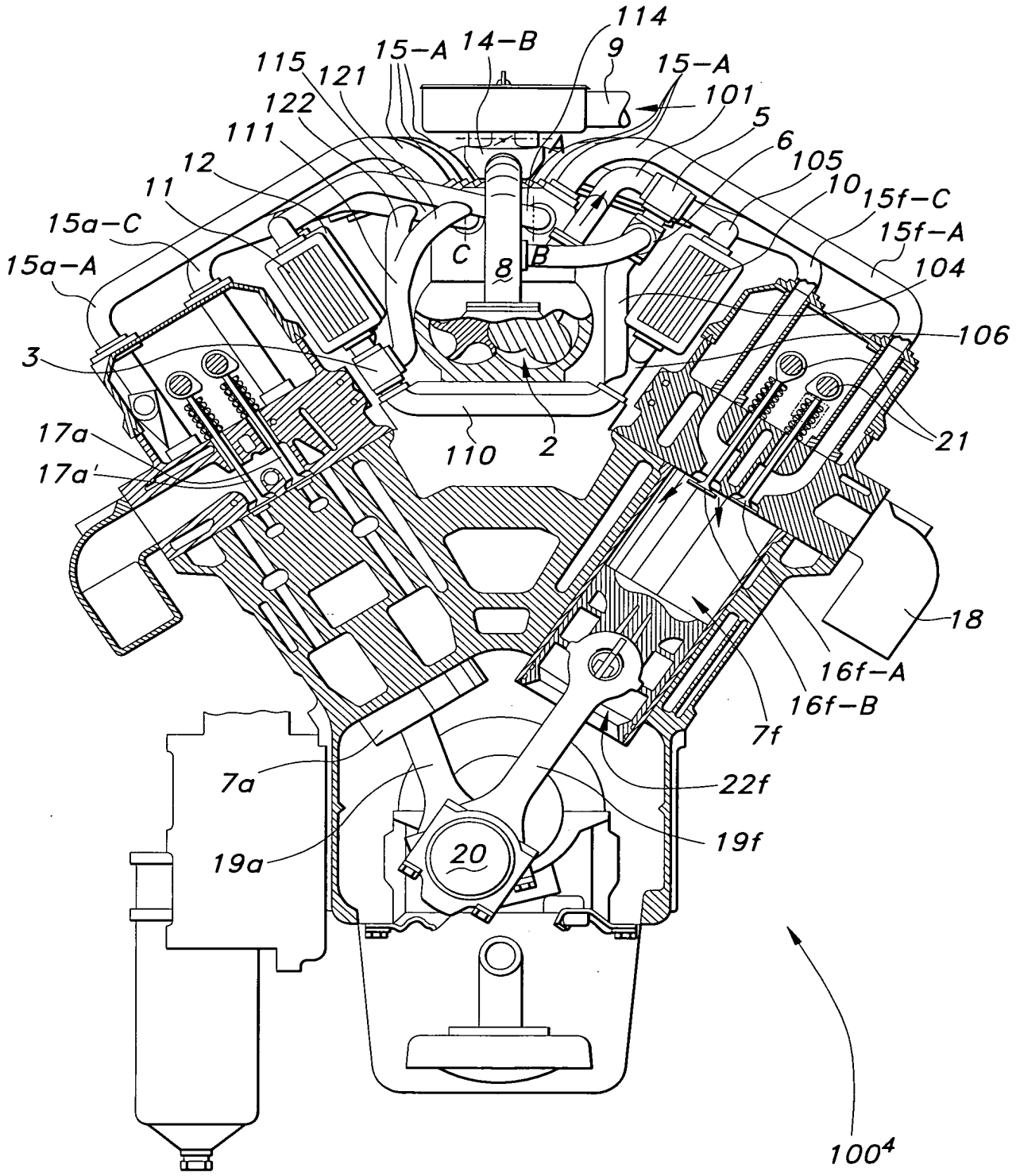

114
9
15-A
14-B
115
121
15-A
122
101
111
5
12
6
105
11
10
15f-C
15a-C
15f-A
15a-A
C
8
B
104
106
3
2
110
21
17a
17a'
18
16f-A
16f-B
7f
7a
22f
19a
19f
20
100⁴

FIG 4B

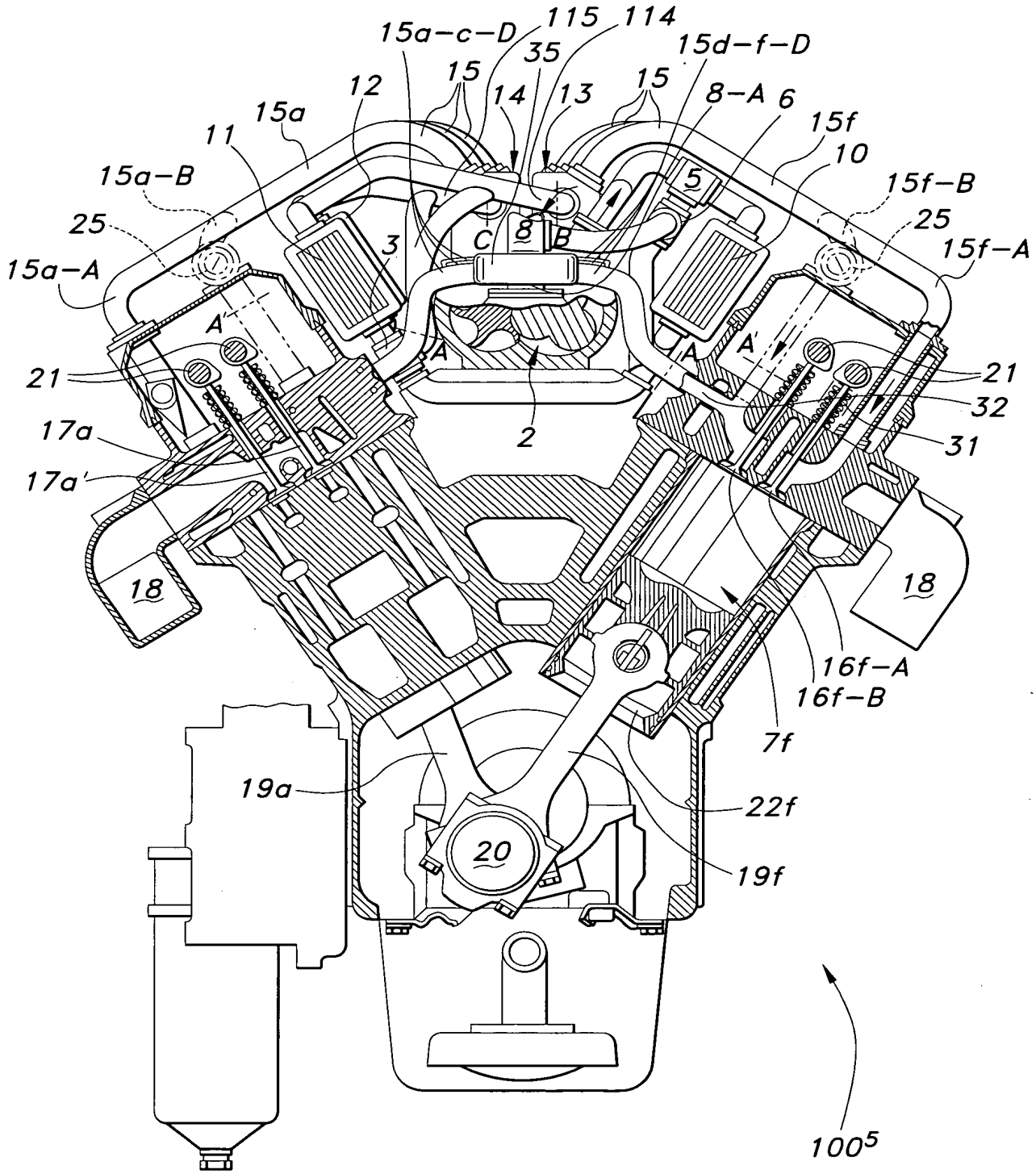

15a-c-D
115
114
15d-f-D
35
15
12
14
13
15
8-A
6
15a
11
15f
10
15a-B
5
15f-B
25
25
15f-A
15a-A
3
C
8
B
A
A'
A
A'
21
21
32
2
31
17a
17a'
18
18
16f-A
16f-B
7f
19a
22f
20
19f
100⁵

FIG 5

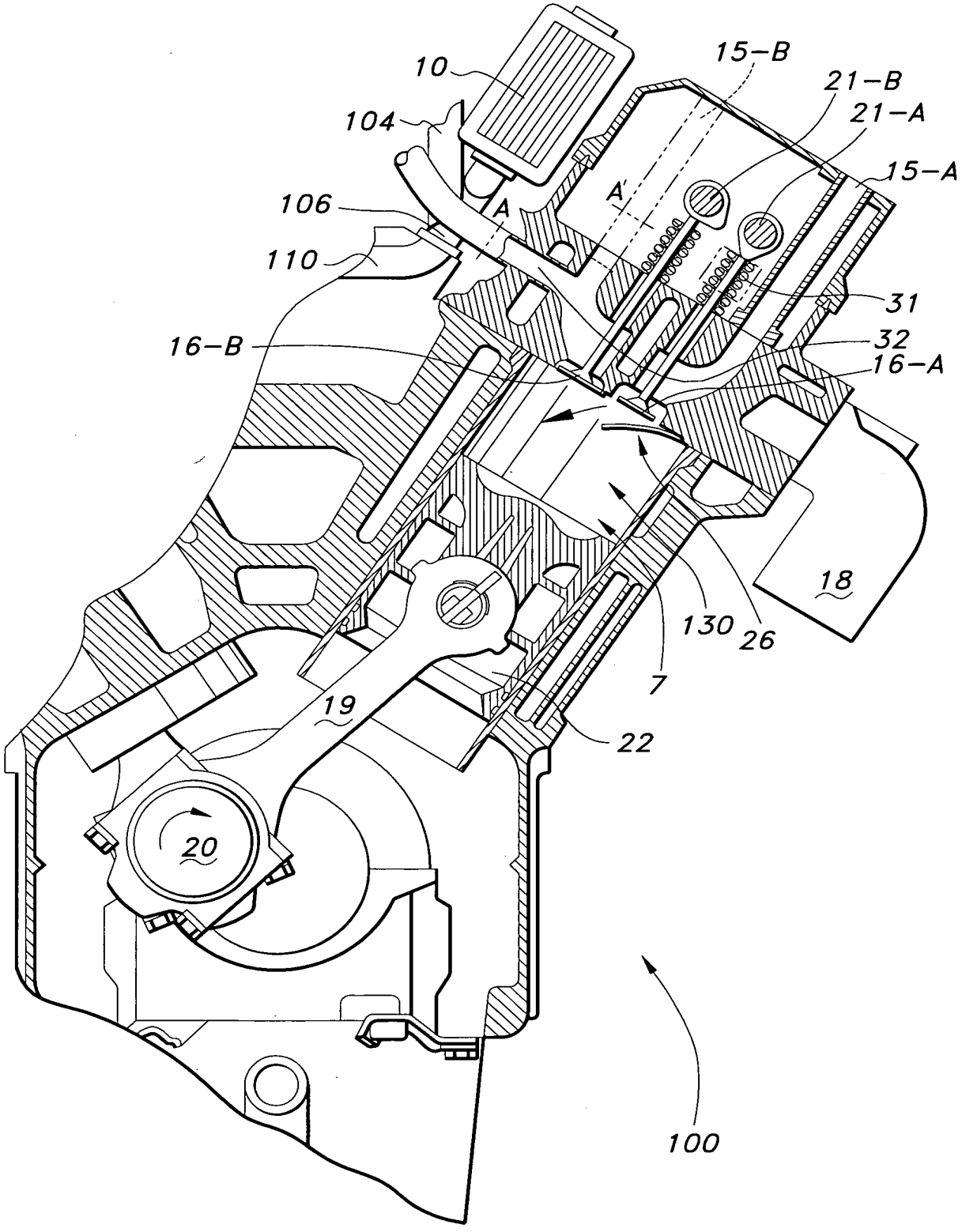

10
15-B
21-B
21-A
104
15-A
A
A'
106
110
31
32
16-B
16-A
18
130
26
7
19
22
20
100

FIG 6

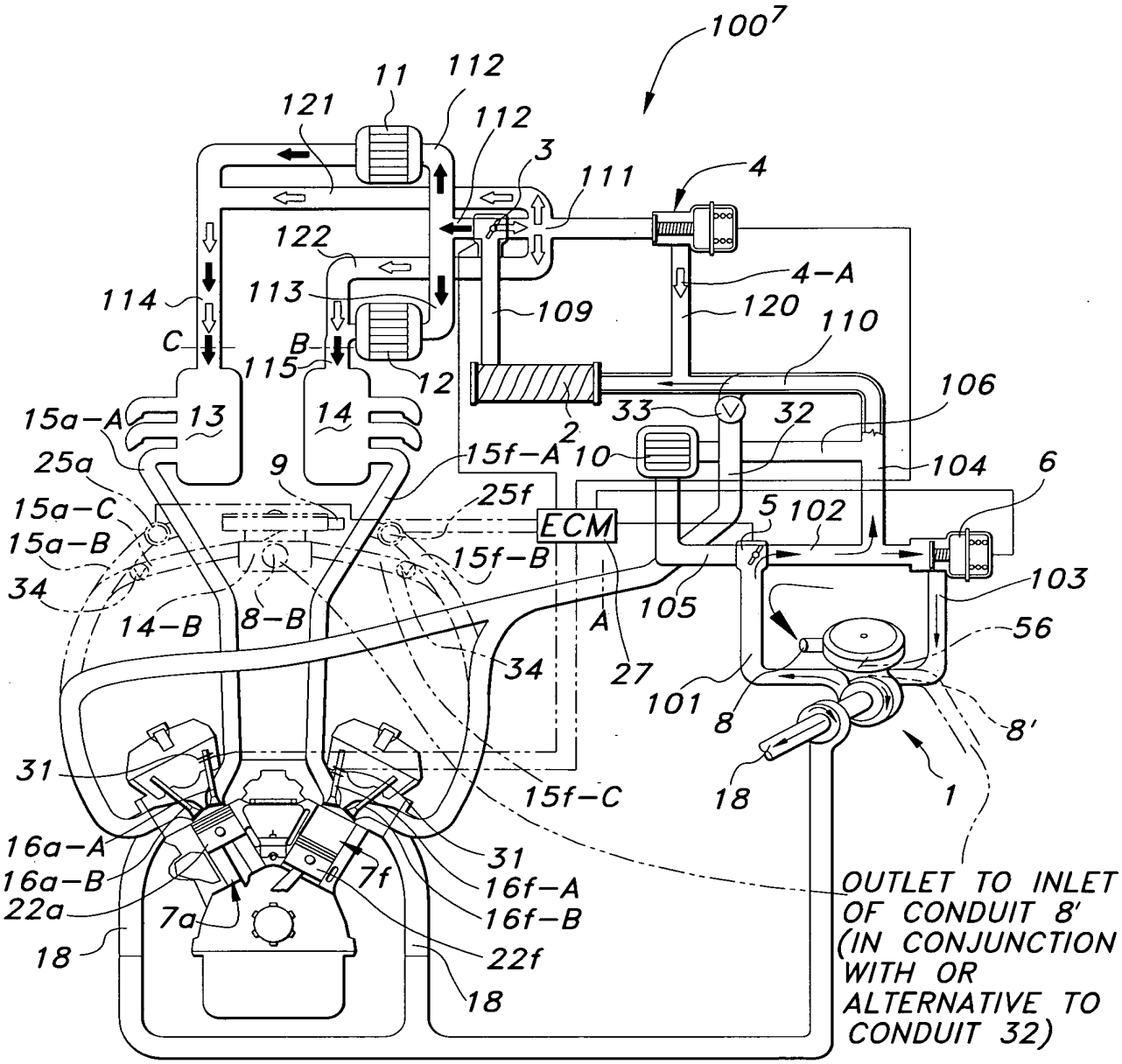

100'
11
112
121
112
3
111
4
122
4-A
114
113
109
120
110
C
B
115
12
106
15a-A
13
14
33
32
2
15f-A
10
104
6
25a
9
25f
5
102
15a-C
ECM
15a-B
15f-B
103
34
105
56
14-B
8-B
A
34
27
101
8
8'
31
18
1
15f-C
16a-A
31
16a-B
7f
16f-A
22a
7a
16f-B
18
22f
18
OUTLET TO INLET OF CONDUIT 8' (IN CONJUNCTION WITH OR ALTERNATIVE TO CONDUIT 32)

FIG 7

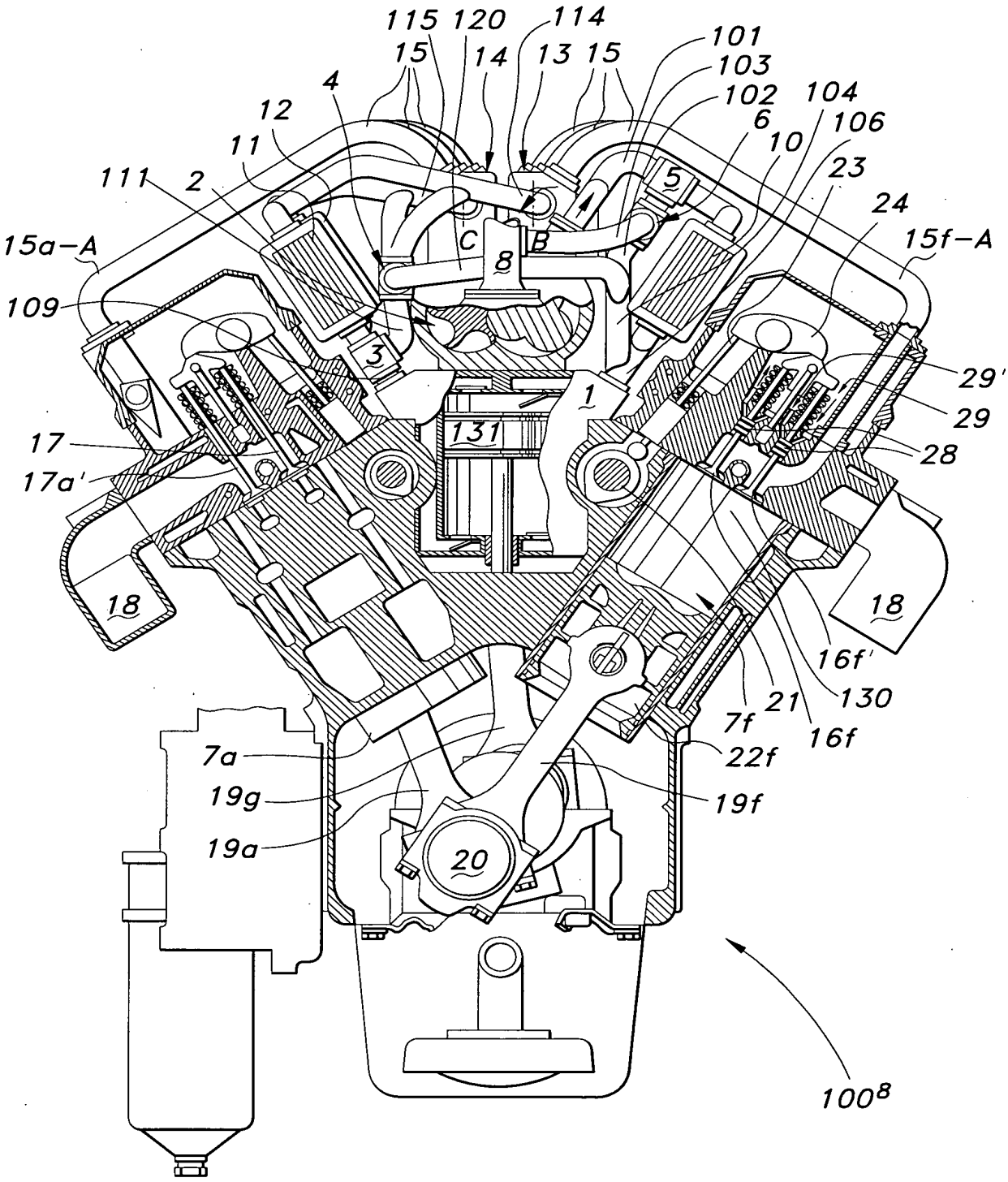

115
120
114
15
14
13
15
101
103
102
104
106
4
12
11
6
10
23
24
111
2
5
15a–A
15f–A
C
8
B
109
3
1
29'
29
131
28
17
17a'
18
18
16f'
130
21
16f
7f
22f
7a
19g
19a
19f
20
100⁸

FIG 8

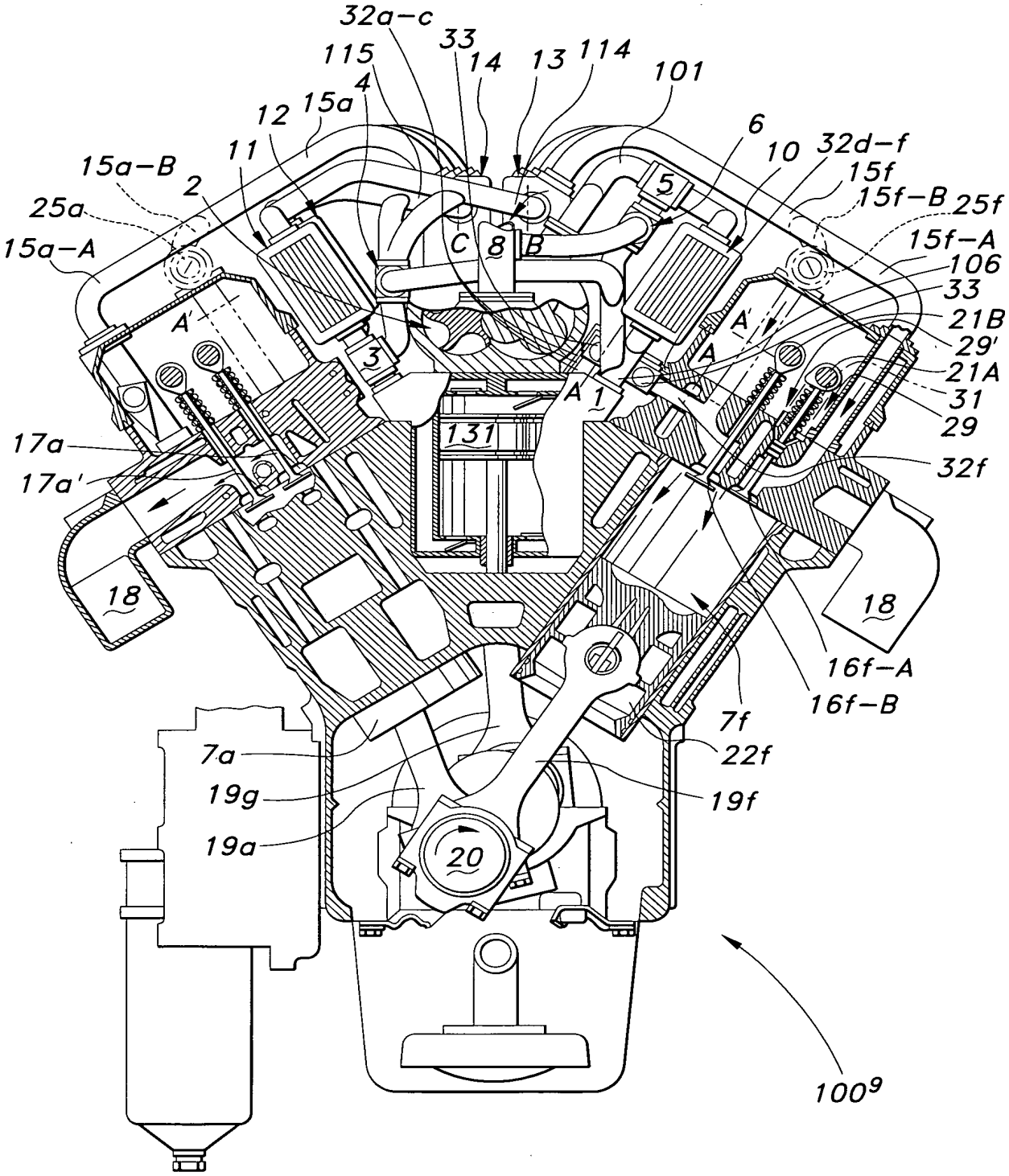

32a–c
33
115
14
13
114
101
4
12
15a
11
6
10
32d–f
15f
15a–B
2
5
15f–B
25f
25a
15a–A
C
8
B
15f–A
106
33
21B
29'
21A
31
29
32f
A'
A
3
1
131
17a
17a'
18
18
16f–A
16f–B
7f
22f
19f
7a
19g
19a
20
100⁹

FIG 9

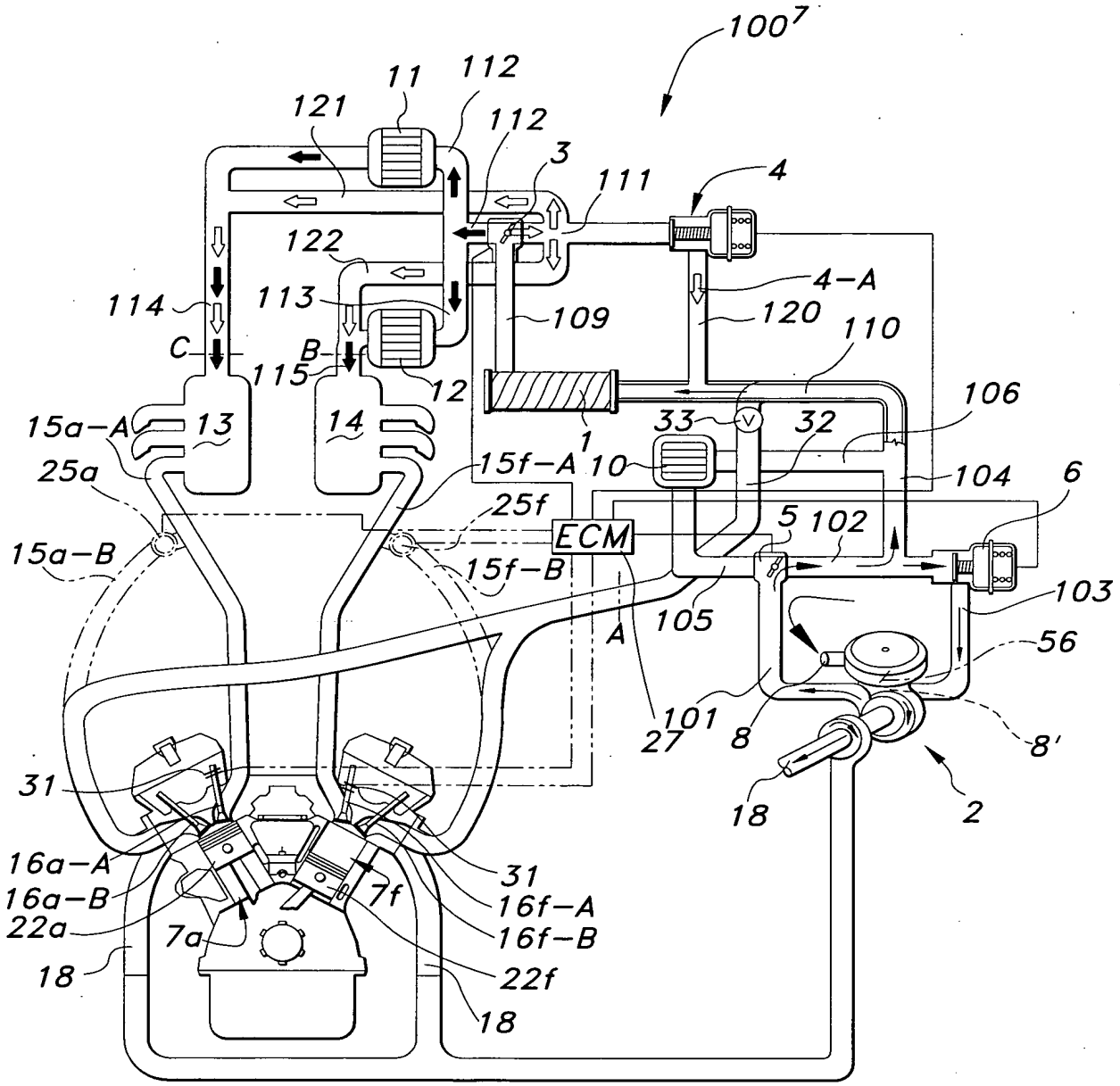

100
11
112
121
112
3
111
4
122
4-A
114
113
109
120
110
C
B
115
12
106
15a-A
13
14
33
32
1
25a
15f-A
10
104
6
25f
ECM
5
102
15a-B
15f-B
103
105
A
56
101
27
8
8'
31
18
2
16a-A
31
16a-B
7f
16f-A
22a
7a
16f-B
18
22f
18

FIG 9B

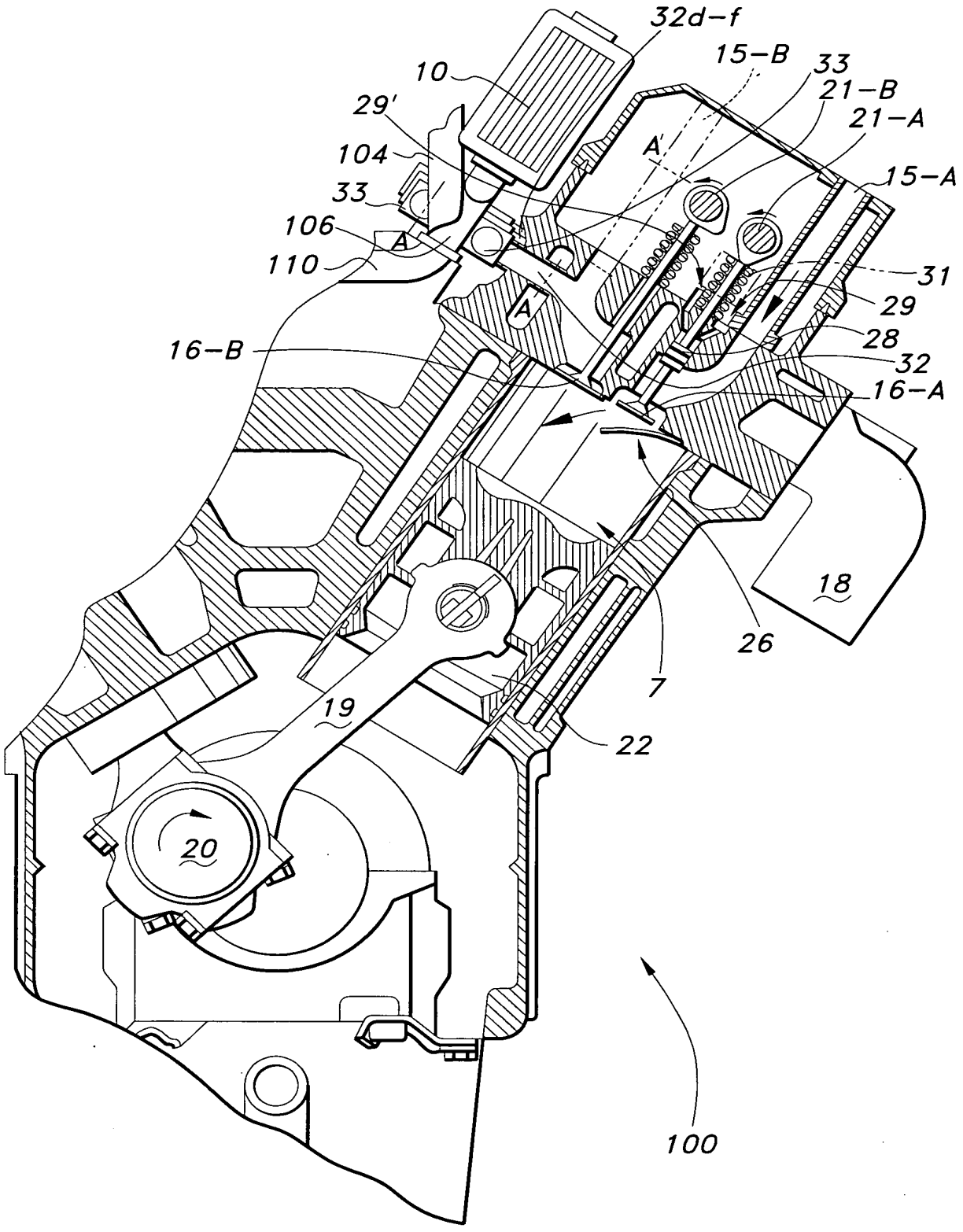

32d–f
15–B
33
21–B
21–A
15–A
10
29'
104
33
106
110
A
A'
31
29
28
32
16–A
16–B
18
26
7
19
22
20
100

FIG 10

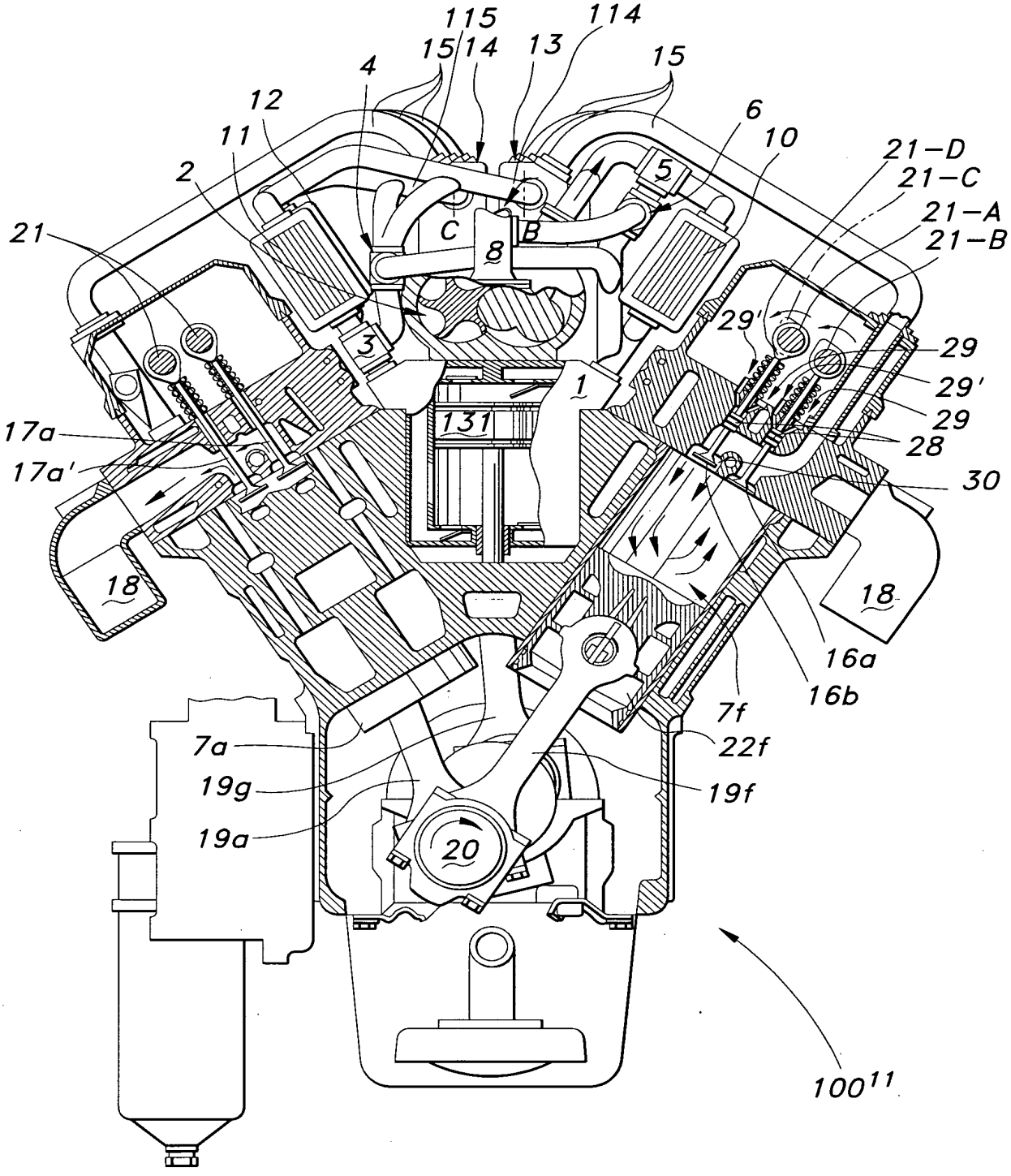
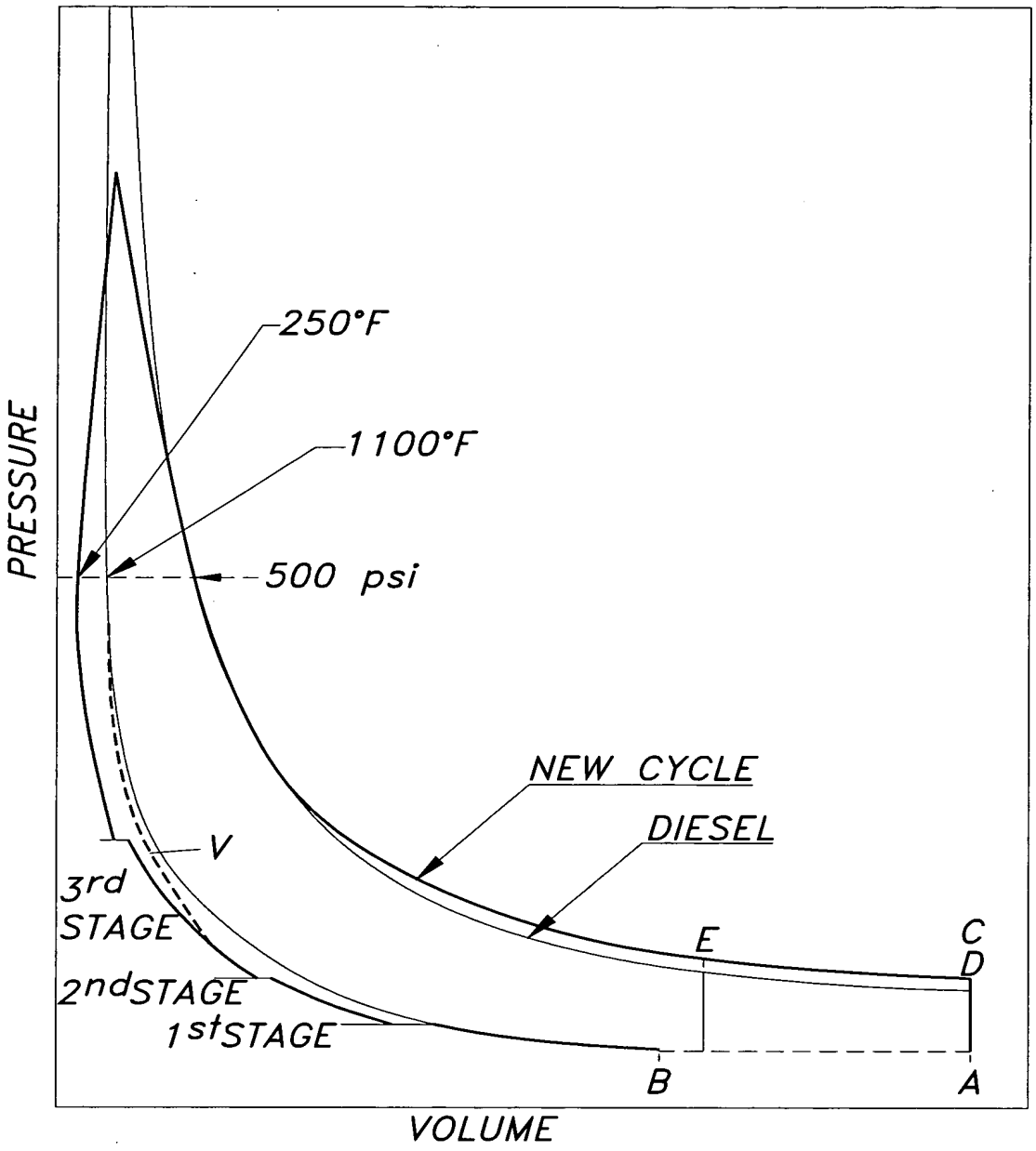

115
15
14
114
13
15
4
12
11
2
6
10
5
21-D
21-C
21-A
21-B
21
C
B
8
3
1
29'
29
29'
29
28
30
131
17a
17a'
18
18
16a
16b
7f
22f
19f
7a
19g
19a
20
100

FIG 11



A – COMPRESSION BEGINS IN 2–STROKE AND 4–STROKE DIESEL CYCLE ENGINE

B – COMPRESSION BEGINS IN 2–STROKE AND 4–STROKE NEW CYCLE ENGINE

C – EXPANSION ENDS IN 4–STROKE DIESEL CYCLE ENGINE

D – EXPANSION ENDS IN 2–STROKE AND 4–STROKE NEW CYCLE ENGINE

E – EXPANSION ENDS (AT EXHAUST BLOW–DOWN) IN 2–STROKE DIESEL CYCLE ENGINE

V – SEE NOTE 1 IN DESCRIPTION

FIG 12

COMPARISON OF OPERATING PARAMETERS OF A HEAVY DUTY TWO-STROKE DIESEL ENGINE (A)

WITH THE ENGINE OF THIS INVENTION (B)

ENGINE	COMPRESSION RATIO OR NOMINAL COMPRESSION RATIO	EFFECTIVE COMP RATIO	COMPRESSION PRESSURE (PSI)	TEMP @ END COMP (DEG F.)	TEMP @ END COMB (DEG F.)	CHARGE DENSITY (LB./CU. FT.)	EXPANSION RATIO	E. R. / C. R.	CHARGE WEIGHT PER REVOLUTION (GRAMS)
A	19:1	19:1	907	1300	3400	1.45	*10:1	0.5	2.06
B(ic)	13:1	2:1	533	250	3000	2.03	**19:1	1.5	2.86
B(bp)	13:1	13:1	533	992	^3100	1.01	**19:1	1.5	1.43
B2(ic)	10:1	2:1	369	250	^2800	1.40	**19:1	1.9	1.98
B2(bp)	10:1	10:1	369	871	^2900	0.75	**19:1	1.9	1.06

* Exhaust valve opens midstroke
** Exhaust valve opens near BDC
(ic) Air charge intercooled except for last stage of compression
(bp) Intercoolers bypassed
^ Estimated

$$\frac{\text{E. R.}}{\text{C. R.}} = \frac{\text{EXPANSION RATIO}}{\text{COMPRESSION RATIO}}$$

FIG 13

COMPARISON OF OPERATING PARAMETERS OF A HEAVY DUTY FOUR-STROKE DIESEL ENGINE (A)

WITH THE ENGINE OF THIS INVENTION (B)

ENGINE	COMPRESSION RATIO OR NOMINAL COMPRESSION RATIO	EFFECTIVE COMP RATIO	COMPRESSION PRESSURE (PSI)	TEMP @ END COMP (DEG F.)	TEMP @ END COMB (DEG F.)	CHARGE DENSITY (LB./CU. FT.)	EXPANSION RATIO	E. R. / C. R.	CHARGE WEIGHT PER REVOLUTION (GRAMS)
A	19:1	19:1	907	1300	3400	1.45	19:1	1.0	*1.03
B(ic)	13:1	2:1	533	250	3000	2.03	19:1	1.5	**2.86
B(bp)	13:1	13:1	533	992	^3100	1.01	19:1	1.5	**1.43
B2(ic)	10:1	2:1	369	250	^2800	1.40	19:1	1.9	**1.98
B2(bp)	10:1	10:1	369	871	^2900	0.75	19:1	1.9	**1.06

* Per revolution, not per firing stroke
** Per revolution and per firing stroke
(ic) Air charge intercooled except for last stage of compression
(bp) Intrecoolers bypassed
^ Estimated

$$\frac{\text{E. R.}}{\text{C. R.}} = \frac{\text{EXPANSION RATIO}}{\text{COMPRESSION RATIO}}$$

FIG14

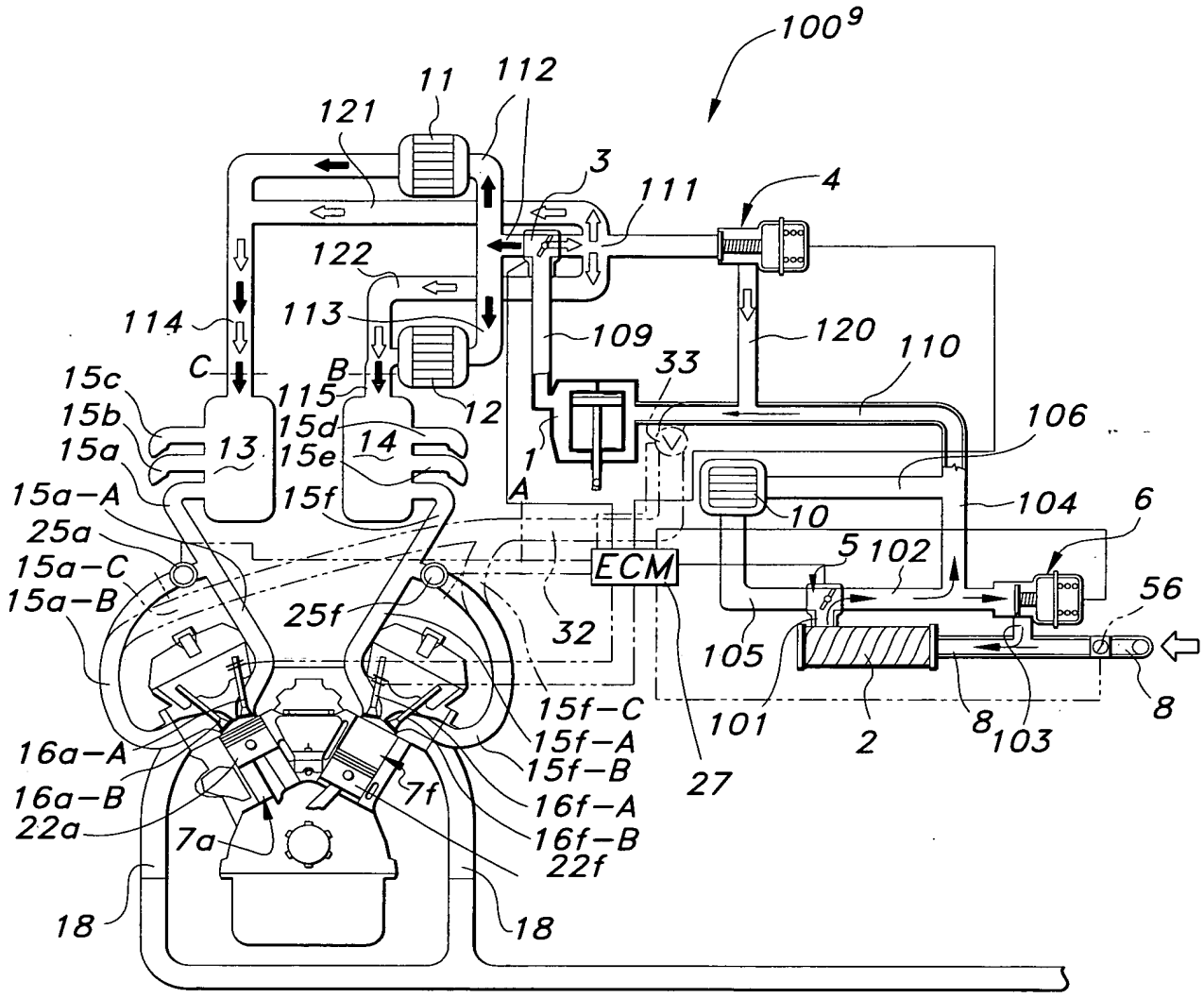

100⁹
11
112
121
3
111
4
122
113
114
109
120
110
C
B
33
15c
15b
15a
115
15d
15e
15f
13
14
12
1
A
106
10
104
6
5
102
ECM
56
15a–A
25a
15a–C
15a–B
25f
32
105
101
2
8
103
8
15f–C
15f–A
15f–B
16f–A
16f–B
22f
27
16a–A
16a–B
22a
7a
7f
18
18

FIG 15

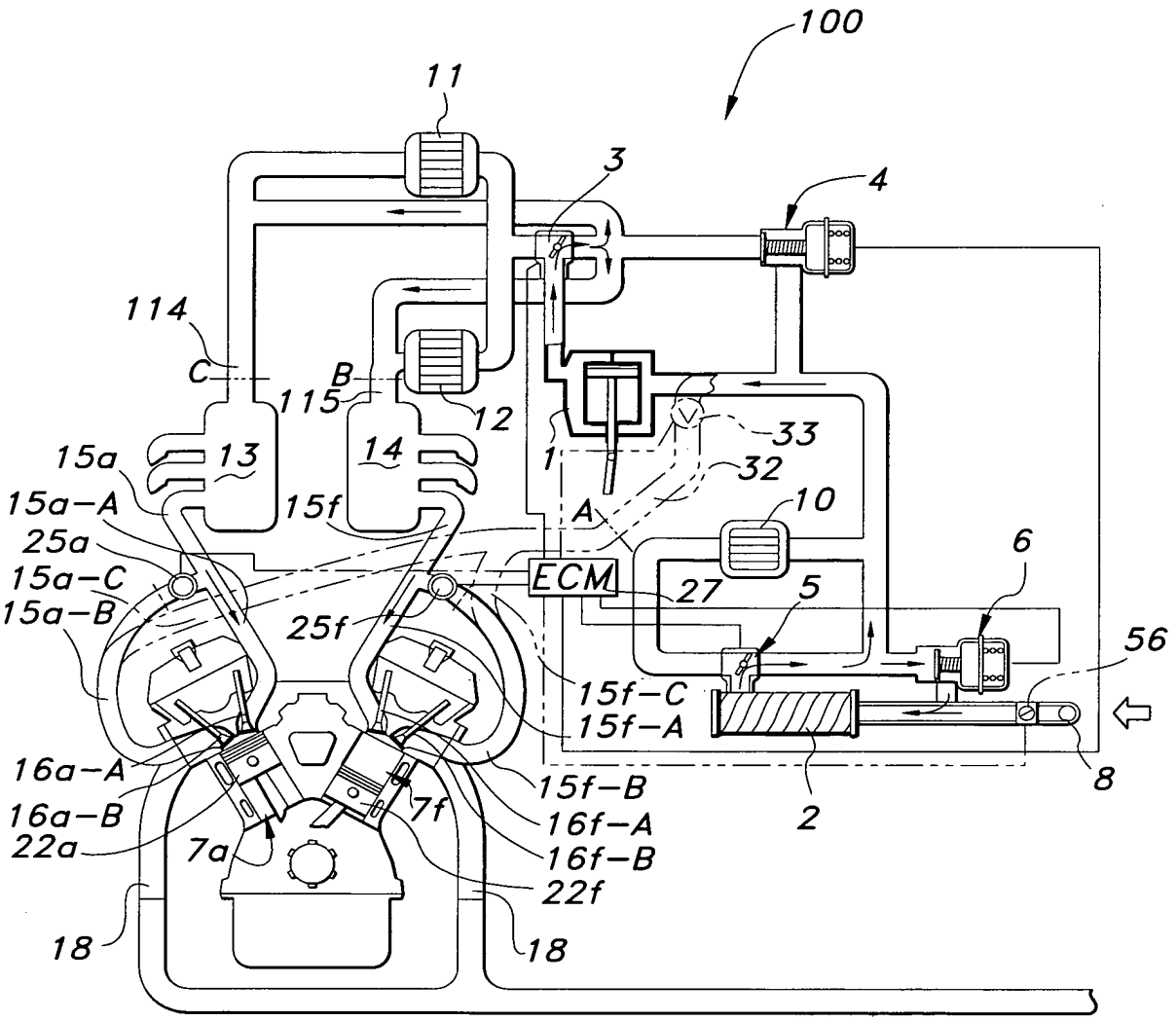

100
11
3
4
114
C
B
115
12
1
33
32
10
15a
13
14
15a-A
15f
A
25a
15a-C
ECM
27
6
5
15a-B
25f
56
15f-C
15f-A
16a-A
16a-B
22a
7a
7f
15f-B
16f-A
16f-B
22f
2
8
18
18

FIG 16

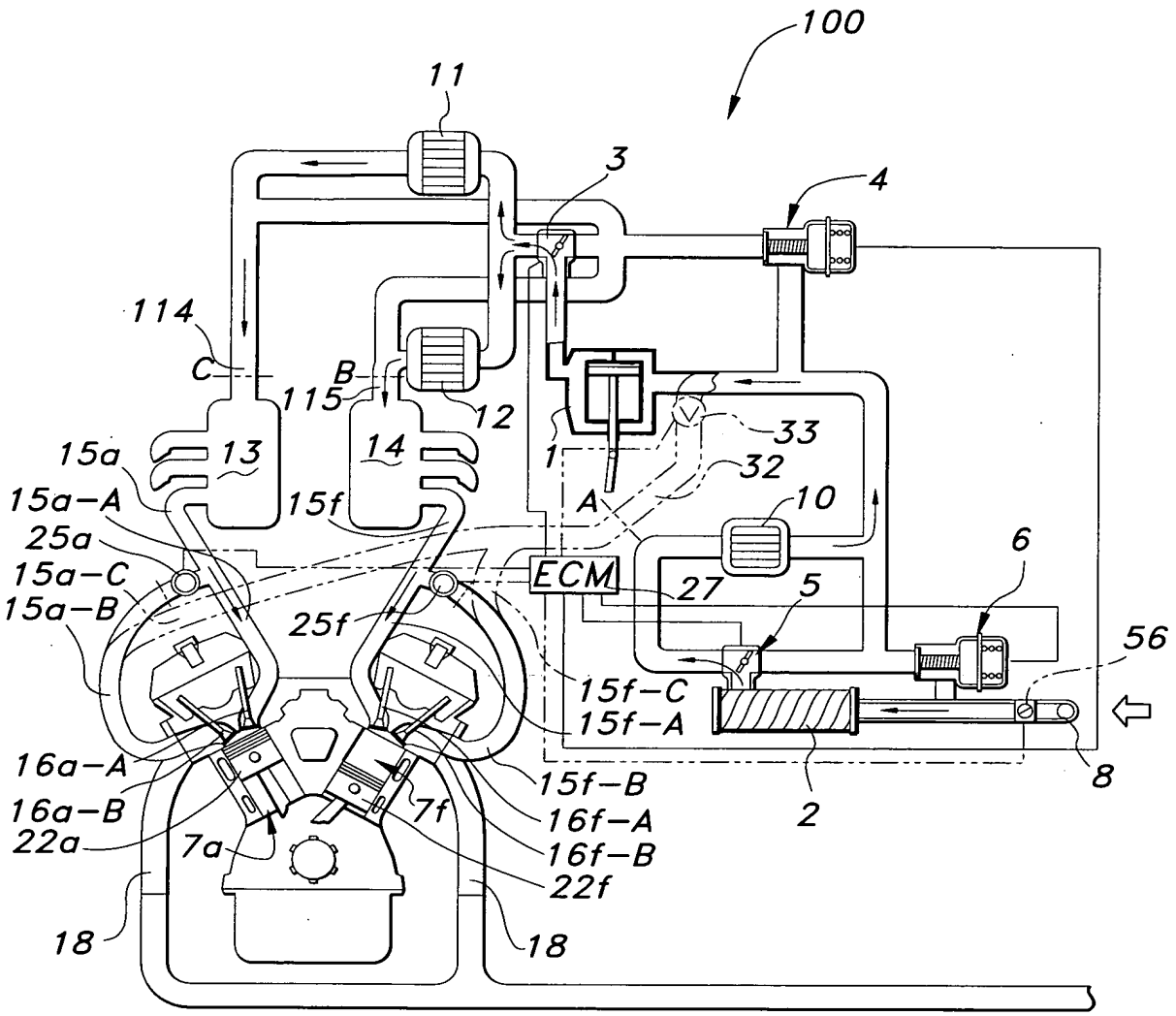

100
11
3
4
114
C
B
115
12
1
33
32
A
10
15a
13
14
15f
15a-A
25a
15a-C
15a-B
ECM
27
5
6
56
25f
15f-C
15f-A
16a-A
16a-B
22a
7a
7f
15f-B
16f-A
16f-B
22f
2
8
18
18

FIG 17

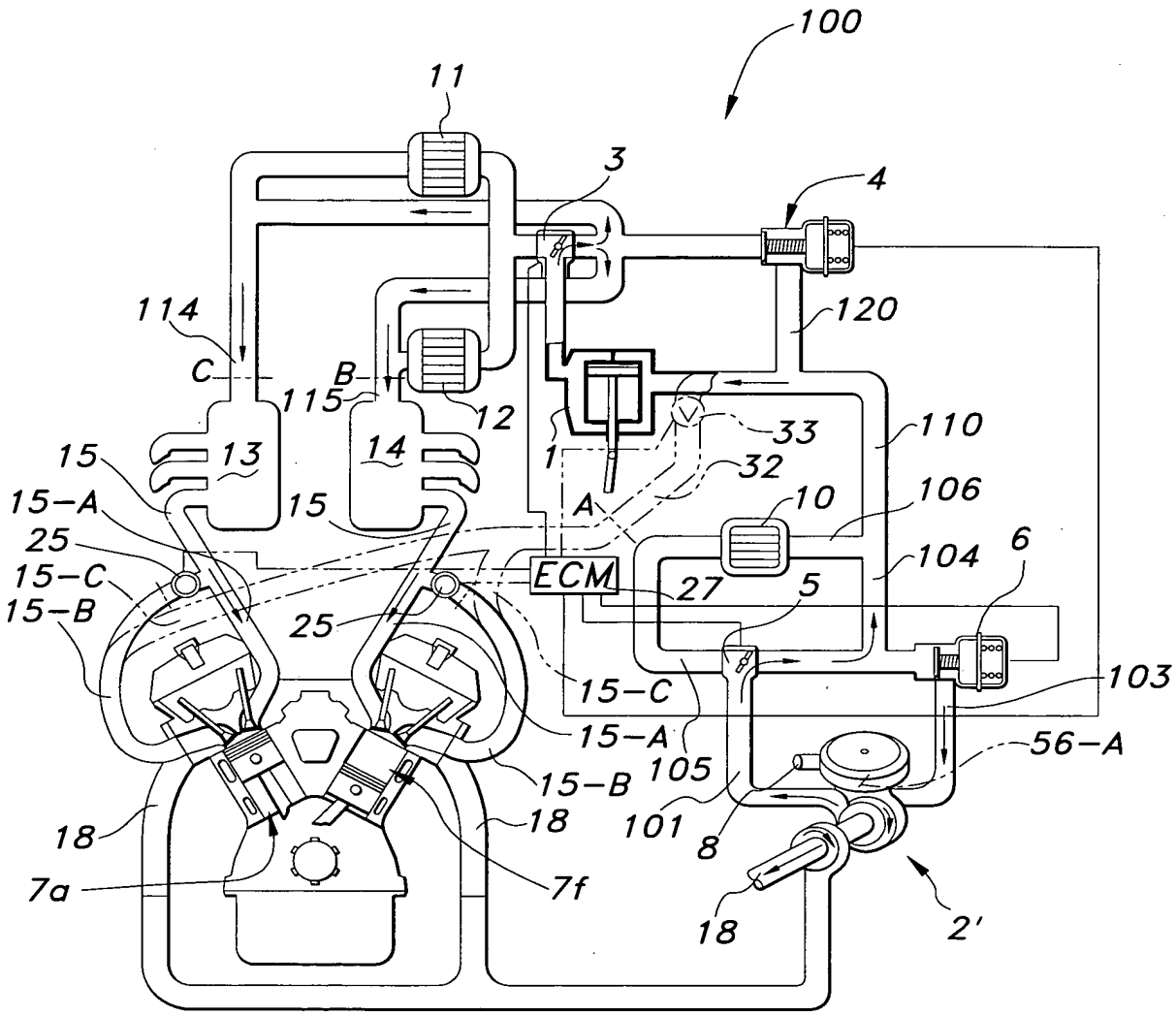

100
11
3
4
120
114
C
B
115
12
1
33
110
32
15
13
14
15
A
10
106
15-A
25
15-C
15-B
ECM
27
5
104
6
25
15-C
103
15-A
105
56-A
15-B
18
18
101
8
18
7a
7f
18
2'

FIG 18

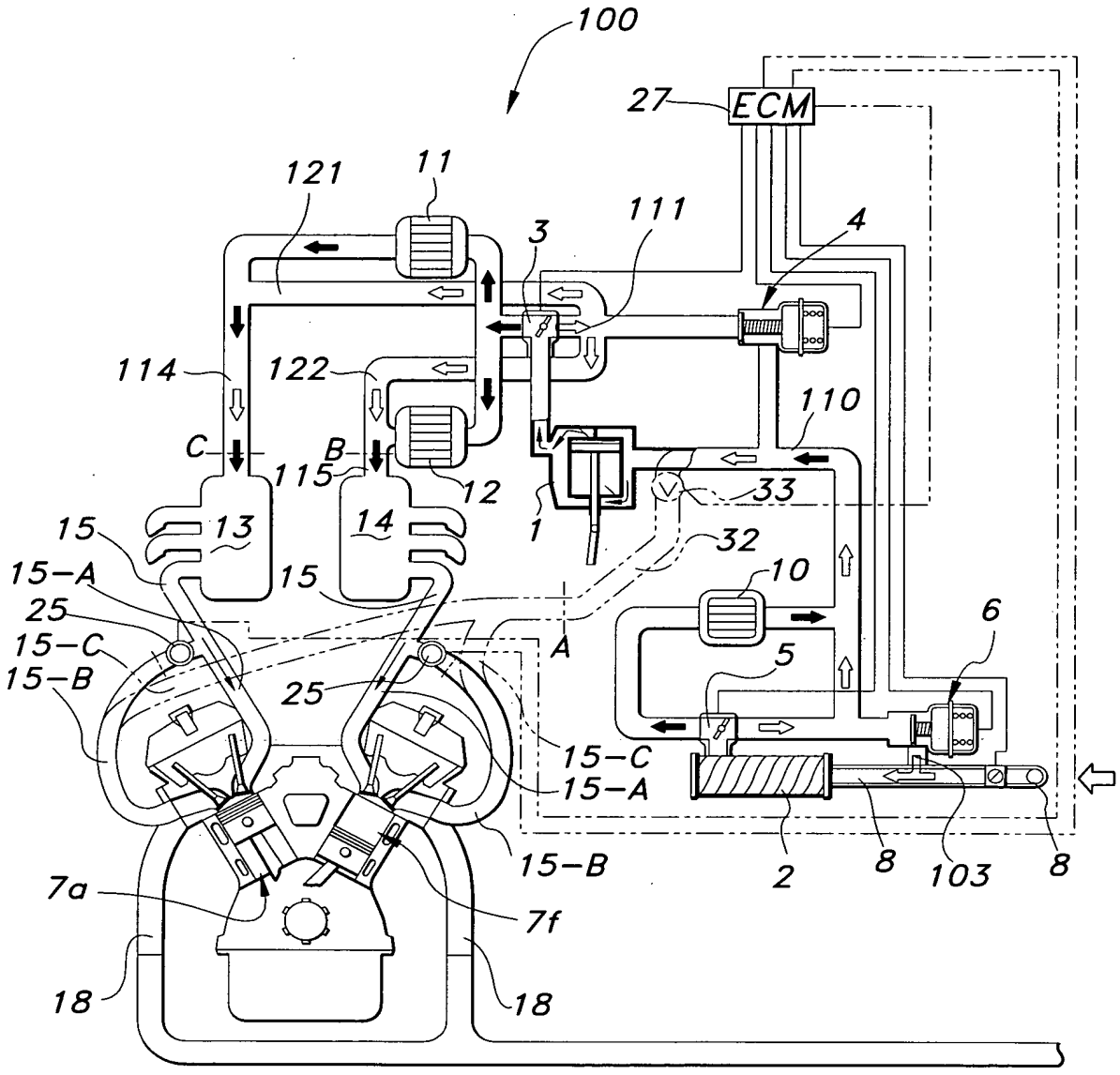

100
27
ECM
121
11
111
3
4
114
122
110
C
B
115
12
1
33
32
15
13
14
15-A
15
10
25
15-C
A
6
15-B
25
5
15-C
15-A
15-B
2
8
103
8
7a
7f
18
18

FIG 19

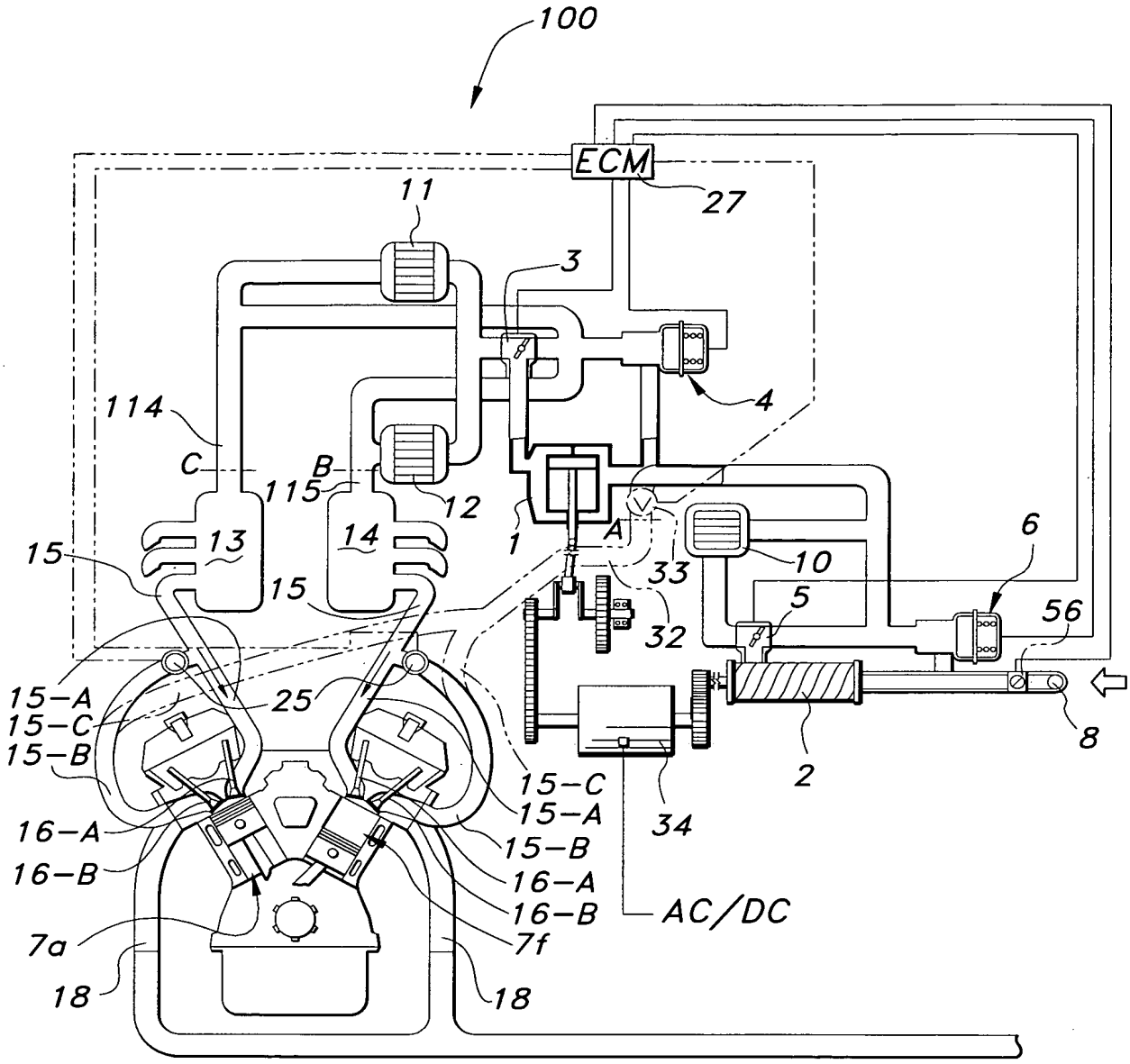

100
ECM
27
11
3
4
114
C
B
115
12
1
A
13
14
15
15
33
10
6
5
56
32
15-A
15-C
15-B
25
8
2
15-C
15-A
15-B
16-A
16-B
34
AC/DC
16-A
16-B
7a
7f
18
18

FIG 20

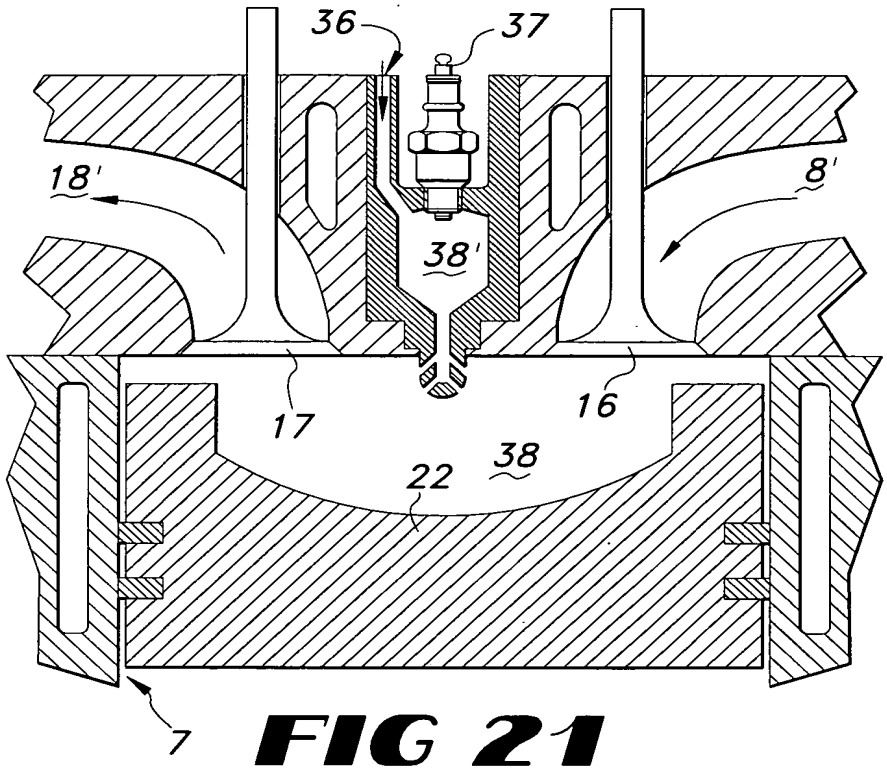


FIG 21

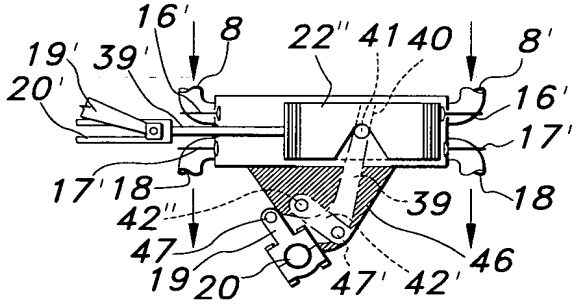


FIG 23

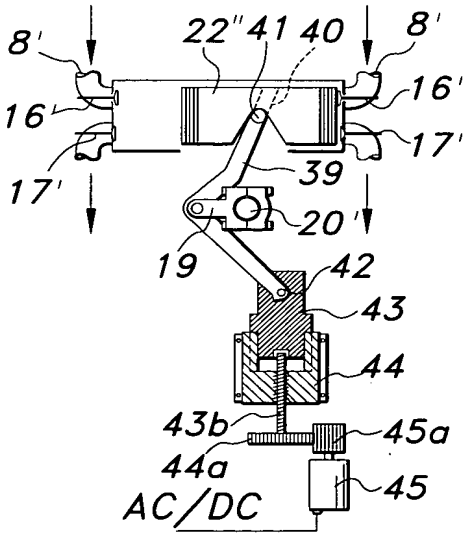


FIG 22

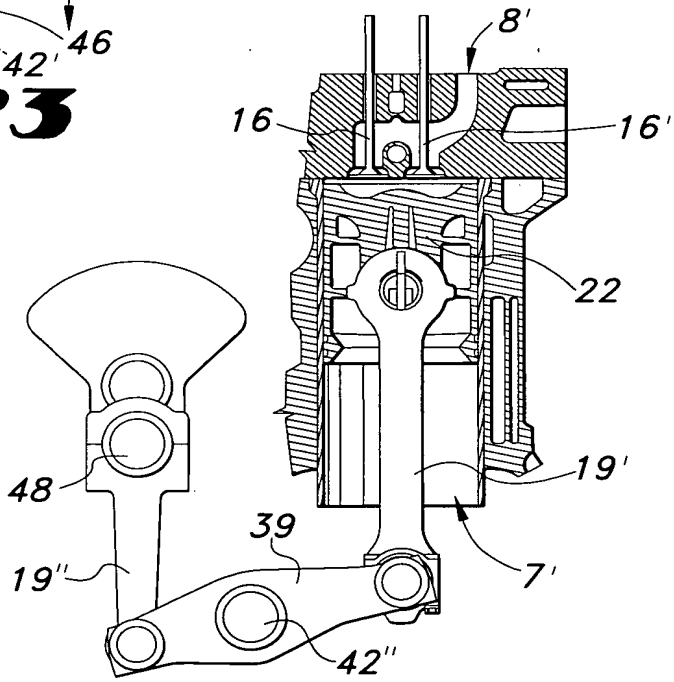


FIG 24

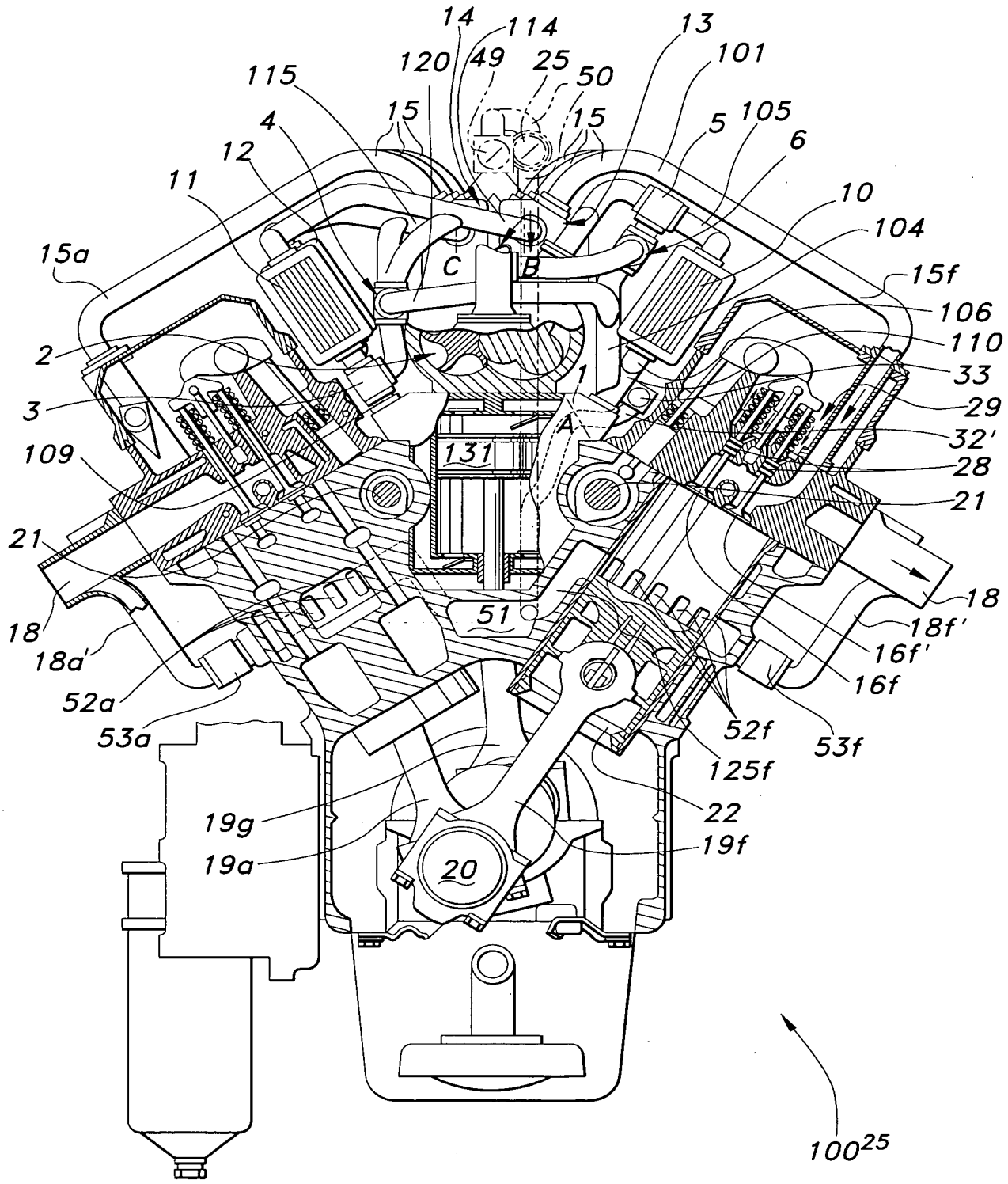

14
114
13
120
49
25
50
101
115
15
15
5
105
4
6
12
11
10
104
15a
C
B
15f
106
2
110
1
33
3
A
29
32'
109
131
28
21
21
18
51
18
18f'
18a'
16f'
16f
52a
52f
53a
53f
125f
22
19g
19f
19a
20
100 25

FIG 25

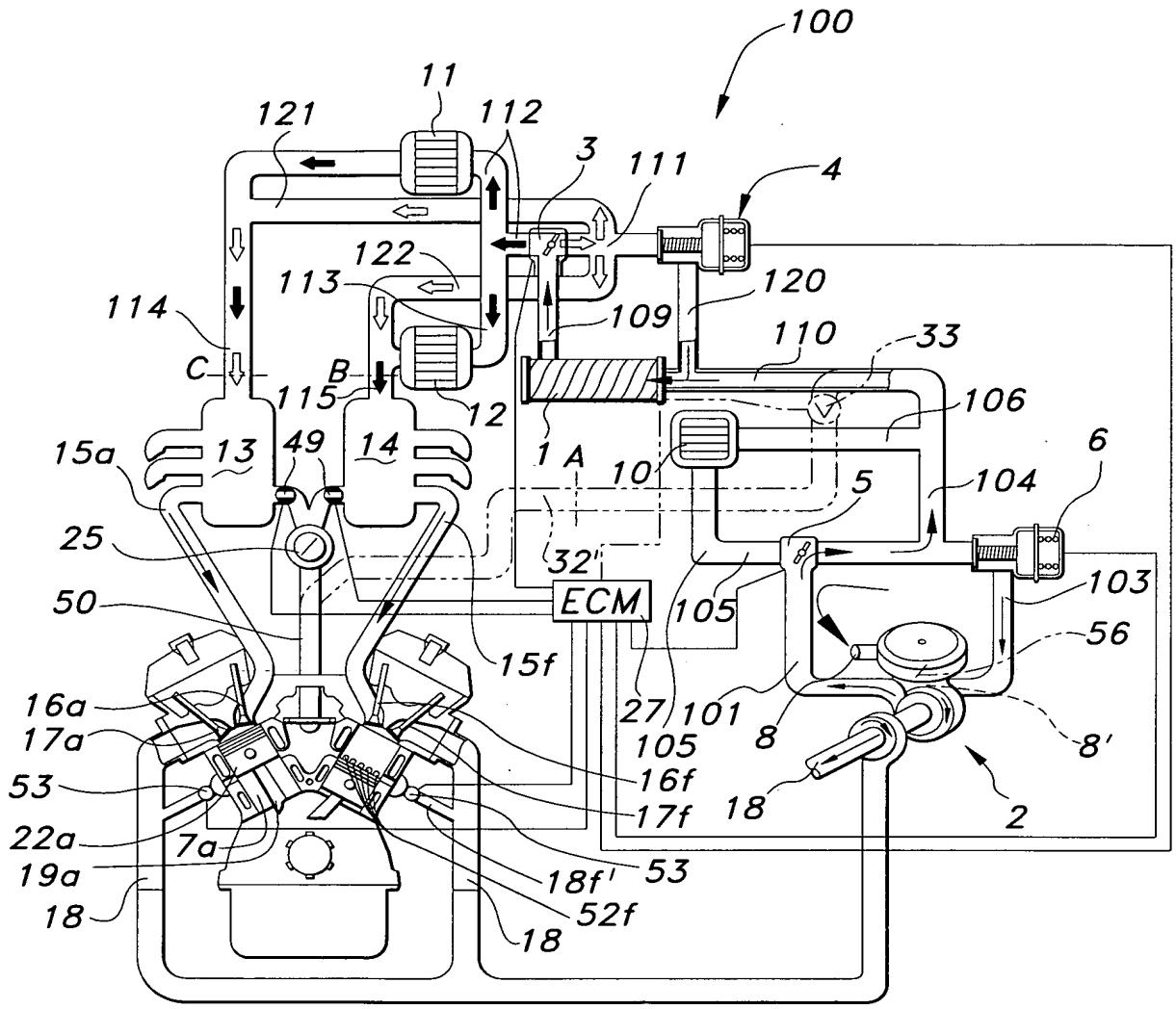

100
11
121
112
3
111
4
122
113
120
114
109
110
33
C
B
115
12
106
1 A
10
15a
13
49
14
6
5
104
25
32'
ECM
103
50
105
56
15f
27
101
16a
105
8
8'
17a
16f
53
17f
18
2
22a
7a
53
19a
18f'
52f
18
18

FIG 26

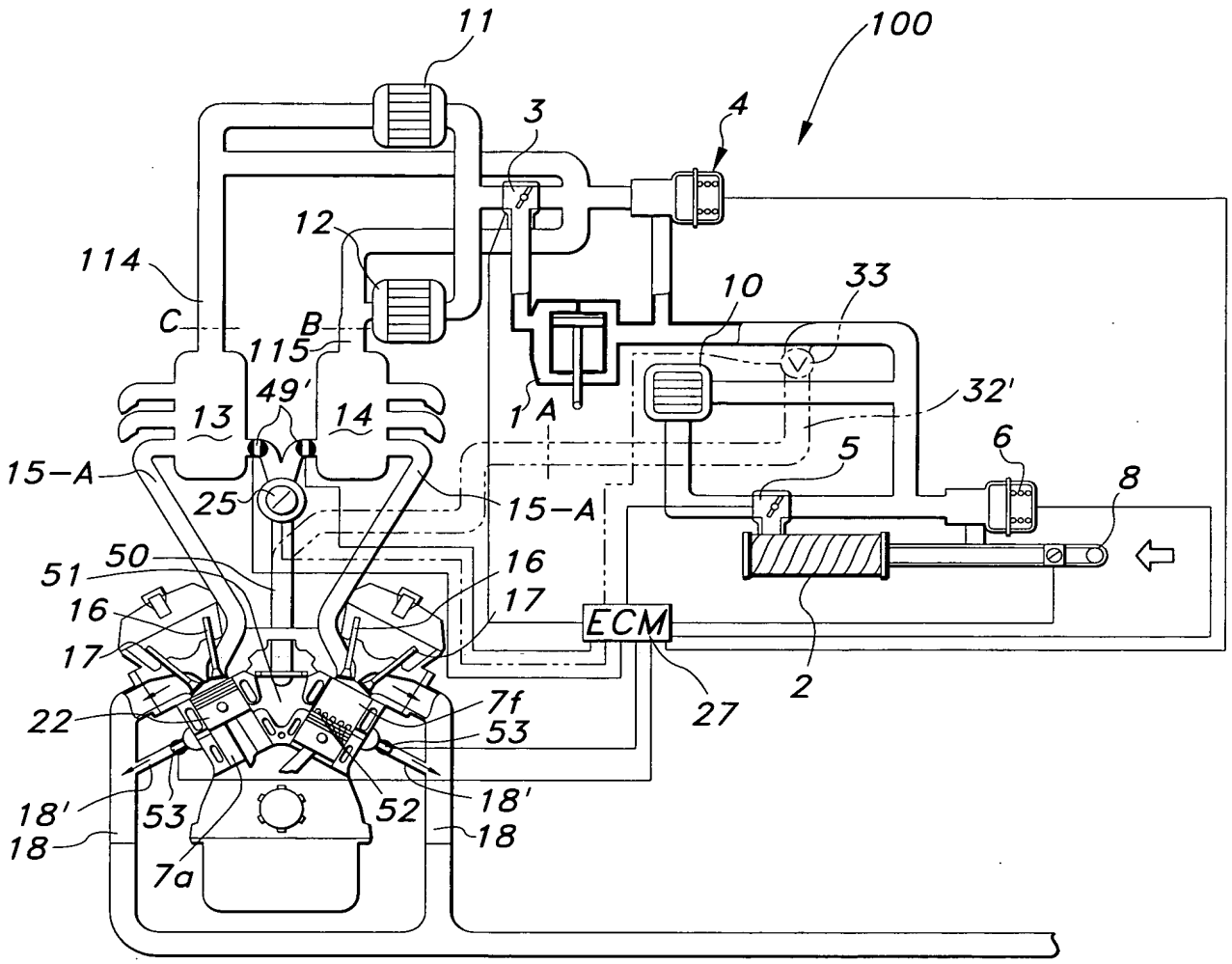

11
100
3
4
12
114
C
B
115
10
33
49'
13
14
1'
A
32'
5
6
8
15-A
25
15-A
50
51
16
17
16
17
ECM
2
27
22
7f
53
18'
53
52
18'
18
18
7a

FIG 27

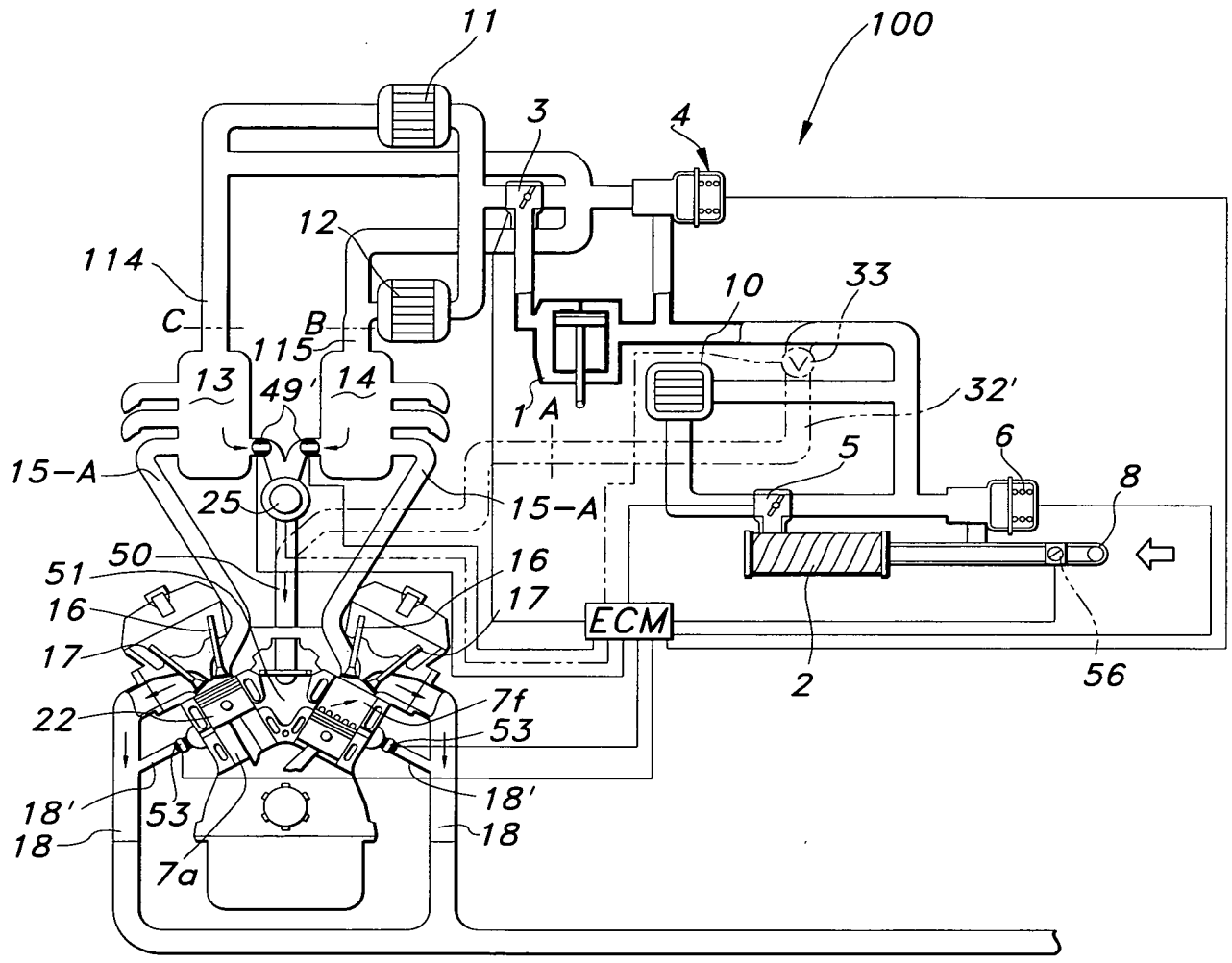

11
100
3
4
12
114
C
B
115
13
49'
14
10
33
1
A
32'
6
5
8
15-A
25
15-A
50
51
16
17
16
17
ECM
2
56
22
7f
53
18'
53
18'
18
18
7a

FIG 28

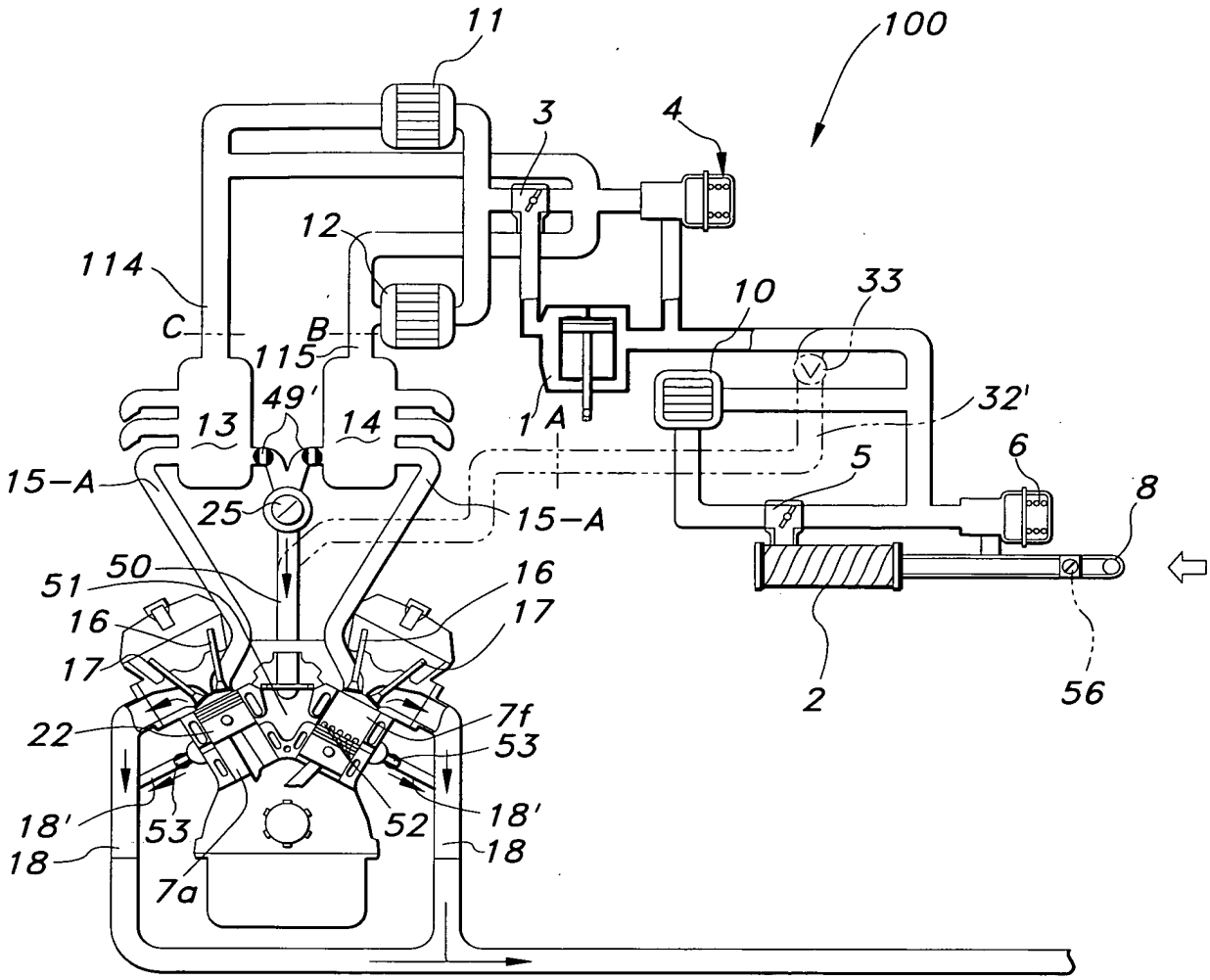

11
100
3
4
12
114
C
B
115
49'
13
14
1'
A
10
33
32'
6
5
8
15-A
25
15-A
51
50
16
17
16
17
22
7f
53
18'
53
52
18'
18
18
7a
2
56

FIG 29

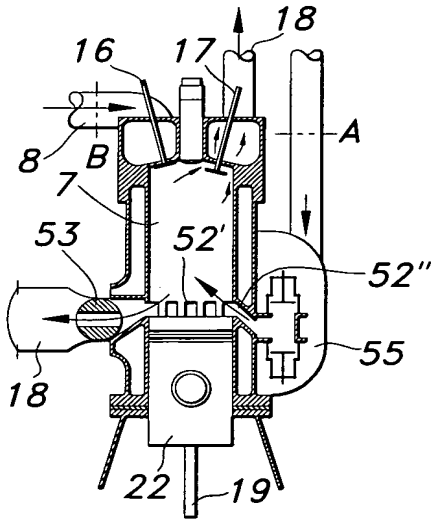

18
16
17
A
8
B
7
53
52'
52"
55
18
22
19

FIG 30

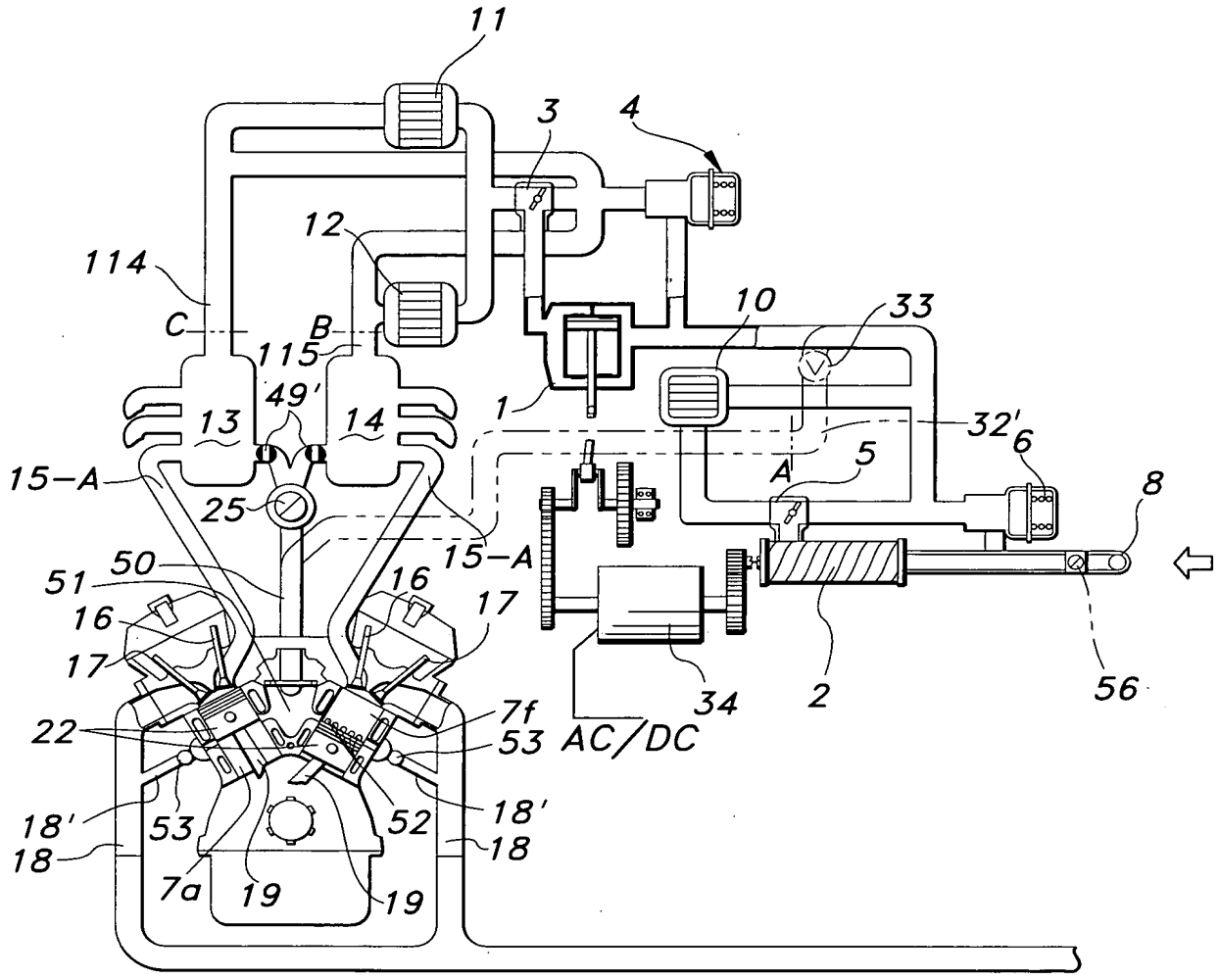

11
3
4
12
114
C
B
115
49'
13
14
10
33
1
32'
6
5
A
8
15-A
25
15-A
50
51
16
17
16
17
22
7f
53
AC/DC
34
2
56
18'
53
52
18'
18
18
7a
19
19

FIG 31

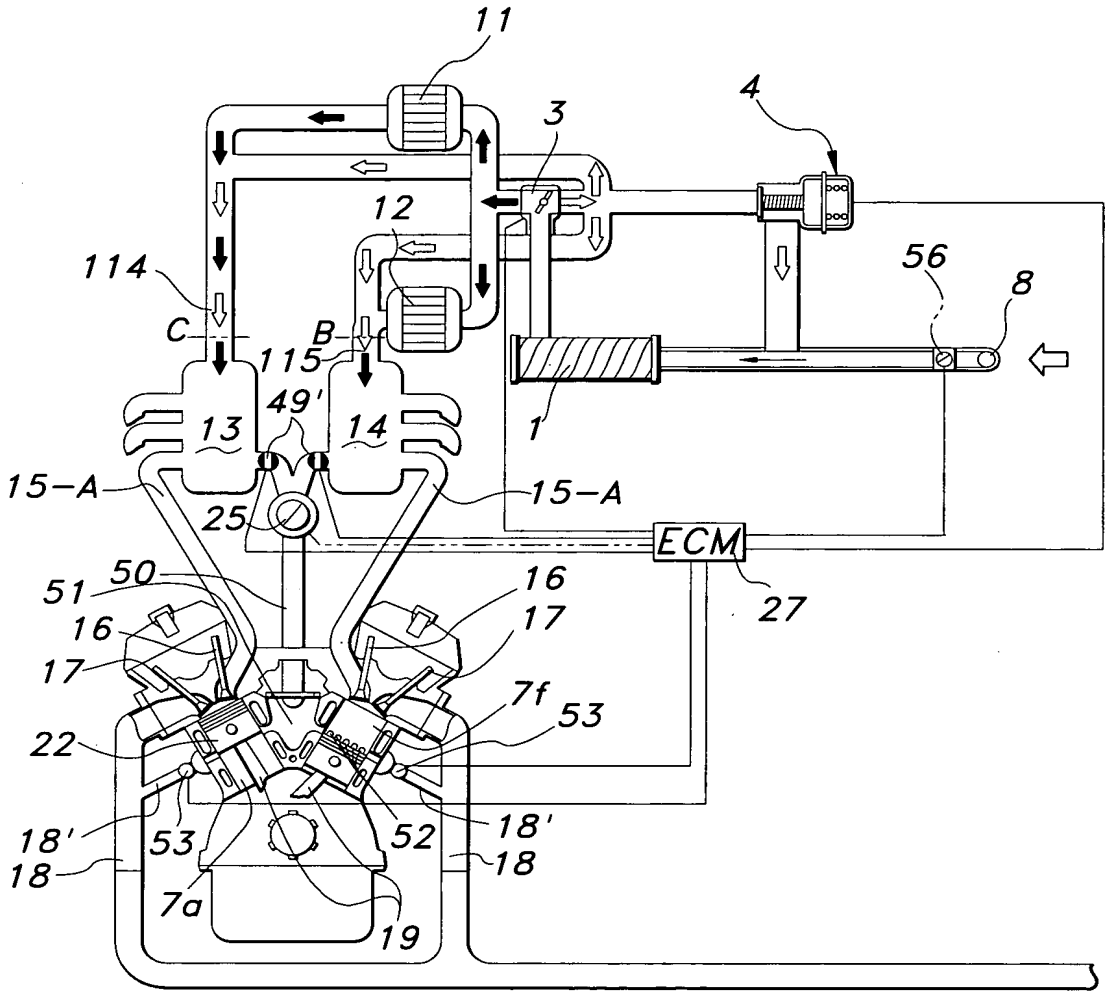

11
4
3
12
114
56
8
C
B
115
49'
13
14
1
15-A
15-A
25
ECM
27
50
51
16
17
16
17
7f
53
22
18'
53
52
18'
18
18
7a
19

FIG 32

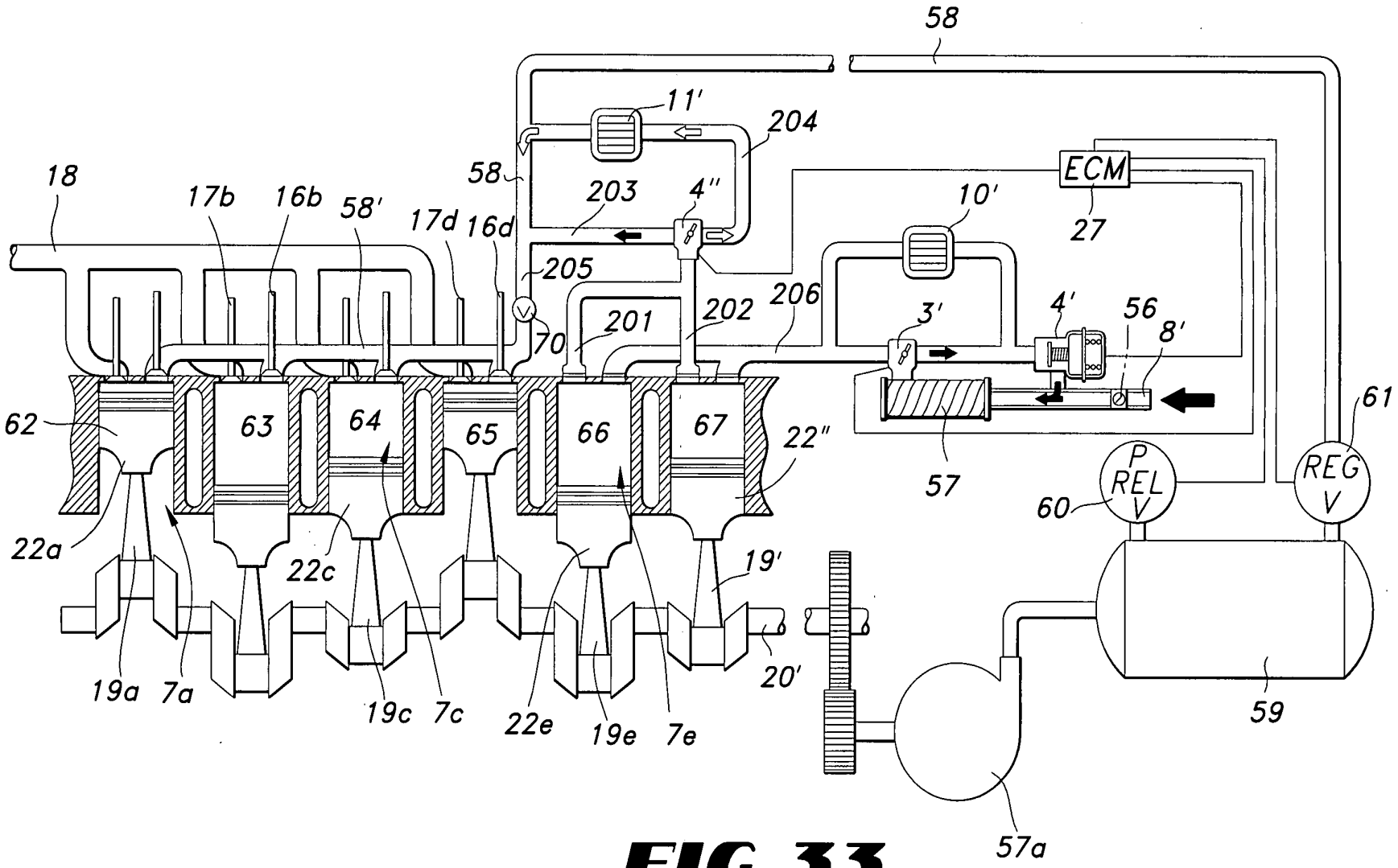


FIG 33

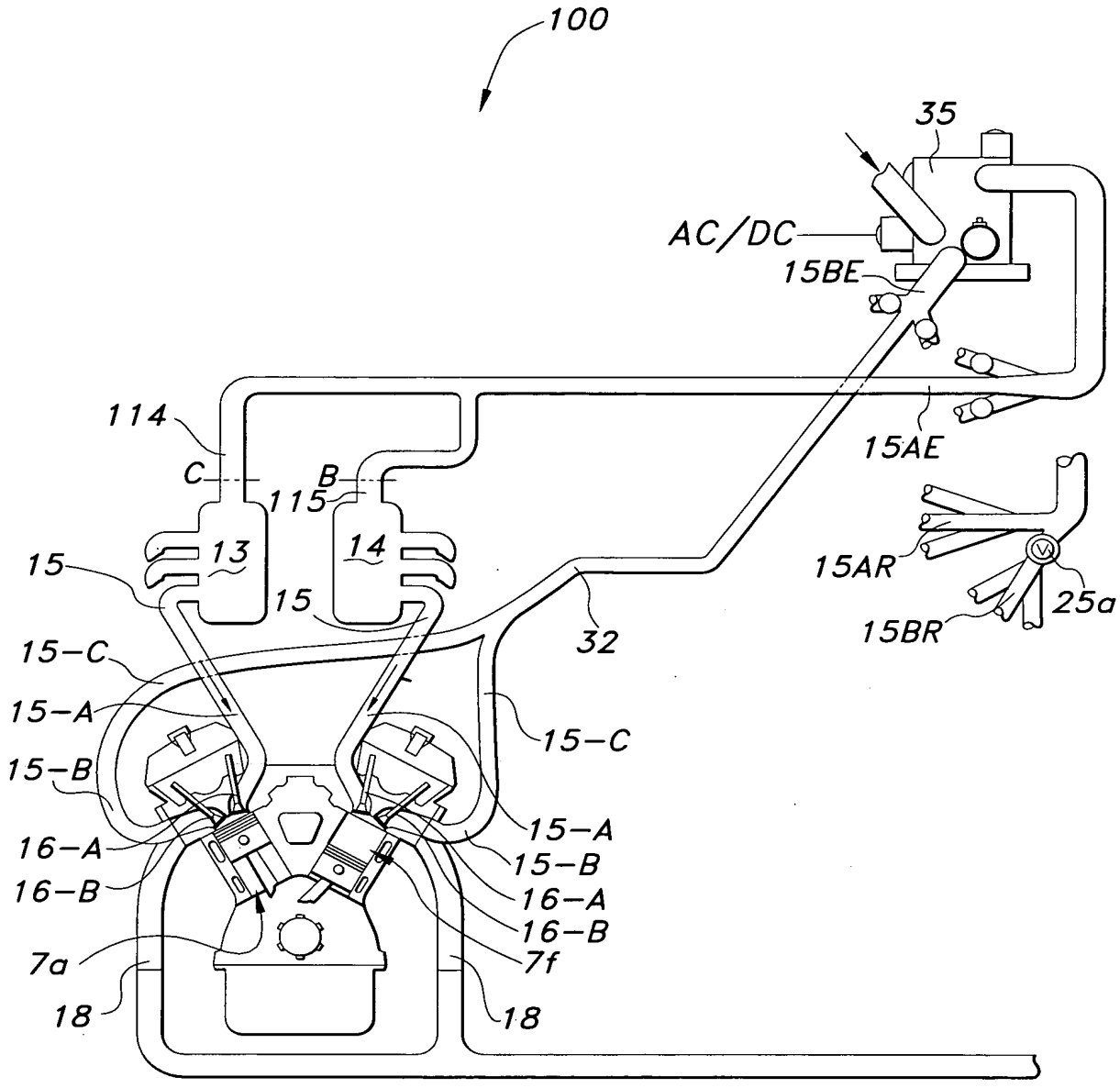

100
35
AC/DC
15BE
15AE
15AR
25a
15BR
114
C
B
115
13
14
15
15
32
15-C
15-A
15-B
16-A
16-B
7a
18
15-C
15-A
15-B
16-A
16-B
7f
18

FIG 34

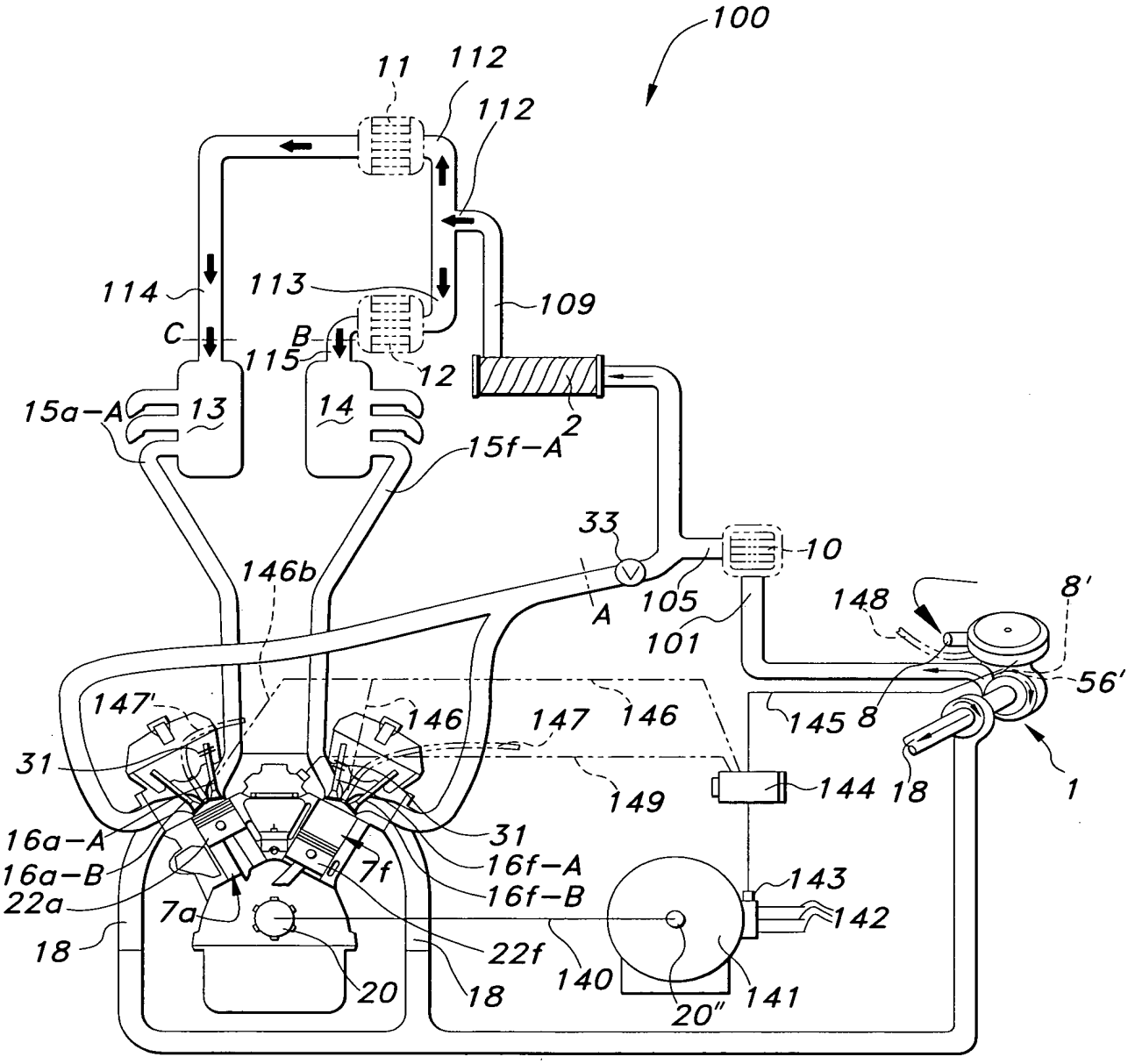

100
11
112
112
114
113
109
C
B
115
12
15a-A
13
14
2
15f-A
33
10
146b
A
105
101
148
8'
56'
147'
146
147
146
145
8
31
149
144
18
1
16a-A
16a-B
22a
7a
18
31
16f-A
16f-B
7f
143
142
22f
140
141
20
18
20"

FIG 35

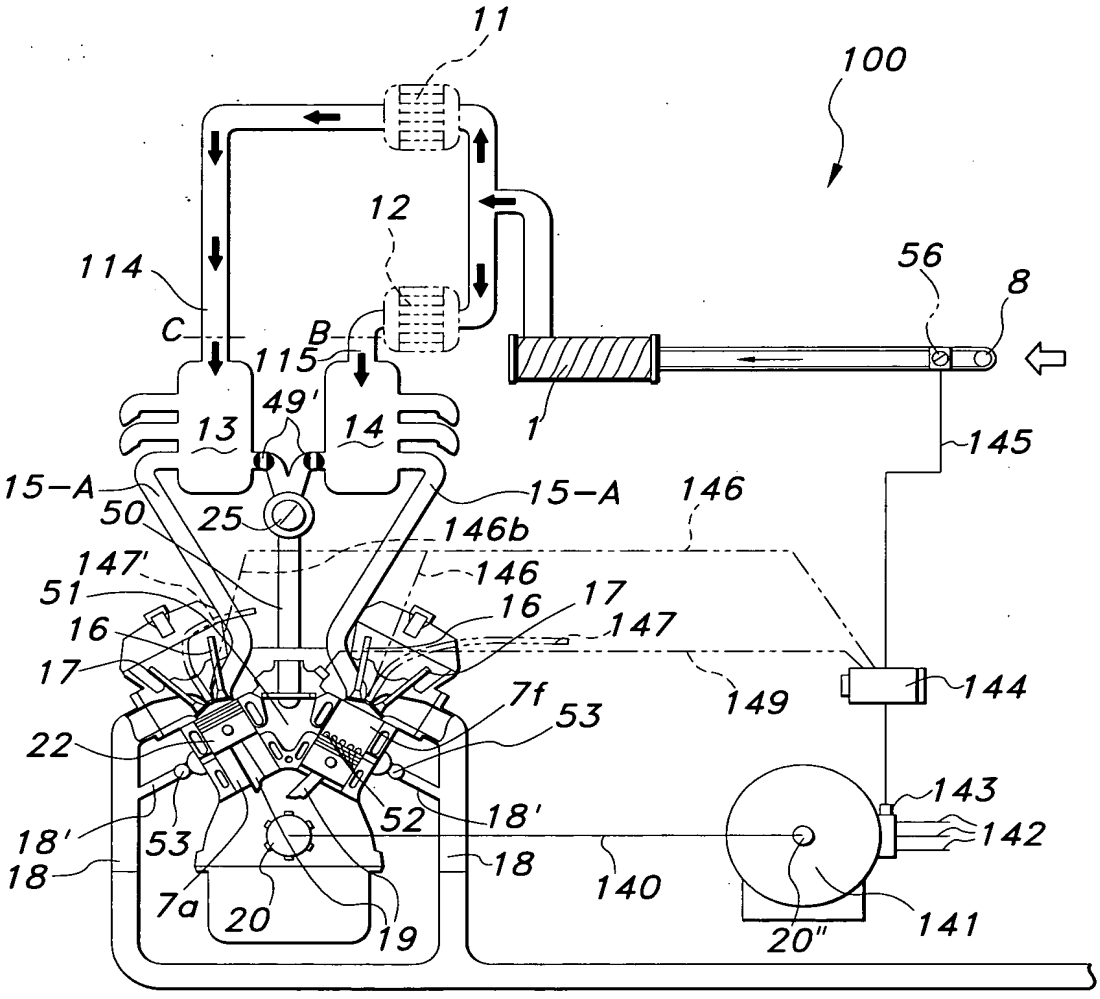


FIG 36